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Contents.

	PAGE
The Future of Fracture	443
Pouring Times	443
Aluminium Alloy Castings	444
Unemployed Iron Workers	444
Explosion in a Metal Refinery	444
Random Shots	444
Institute of British Foundrymen	445
Newark's Effort to Train the Young Foundryman	446
Future of the Steel Industry	446
Small Foundrymen's Conference	446
Nottingham Engineers' Annual Dinner	446
The Reclamation and Reconditioning of Foundry Sands	447
Contributions to Charities	447
Fifty Years a Blacksmith	447
The Manufacture of High-Quality Cast Iron	448
The Measurement of the Cupola Air Blast—II	451
Door Handles and Knockers	452
Electric-Induction Roll Heaters	453
De-rating and Railway Charges	454
Foundry Purchasing—XXX	455
A Set of Cast Bronze Reliefs	456
A Canister	456
The Manufacture of High-Quality Cast Iron	456
Operation of Open-Hearth Furnaces	458
2,000 Years' Old Engine	458
Blacking Factory Fire	458
A New Light Alloys Foundry	458
Trade Talk	460
Contracts Open	460
New Companies	460
Reports and Dividends	460
Staveley Company Active	460
Derby Society of Engineers	462
Obituary	462
The Rise in Spelter	462
Iron and Steel Markets	462

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Future of Fracture.

Many arguments have taken place on fracture *versus* analysis as means of judging pig-iron, and the summary of the views on either side might fairly be made as follows: It is perfectly true that for a given standard pig, increase in silicon affects the fracture, and the silicon can, by the expert eye, be approximately judged by fracture. When a foundry works on rather wide margins, that is when, for instance, there is not much trouble if a particular casting has its silicon content a quarter of one per cent. above or below the proper figure, fracture may be sufficiently reliable.

It does not, however, indicate the influence of elements other than silicon. Before the war, when particular furnaces produced territorially recognisable brands of iron, the other elements were constant enough to make fracture a real thing. To-day that no longer holds, and it is possible to get analysis, say, of a Scotch type iron from Southern furnaces. Hence, fracture is losing ground, for the founder cannot be sure, on knowing the furnace, what the other elements are.

The fracture enthusiasts, keen observers, reply that analysis does not tell the whole story—that the physical nature of the iron is important, apart from composition, and they cite the hot and cold blast iron differences, and others which it is beyond the power of the chemist to explain. The chemist may well reply that analysis does not offer a foolproof way of buying pig, and that judgment in selecting the furnace is just as necessary in purchasing to analysis as to facture.

It is undeniable that buyers are going over more and more to buying to analysis. Unfortunately, they are not content to buy to makers' analysis or to the independent analysts' analysis. They want to buy to their own analysis, with the result that the blast furnace becomes a sort of jobbing furnace producing what the market wants. This we believe to be bad. The interests of the foundryman are regarded when the blast furnace is producing uniform, regular issues day in and day out. The business of the ironfounder is to take those uniform irons, whatever they may be, and mix them scientifically to produce the required results. Buying to analysis should therefore mean to the producers' analysis, because the variety of irons available makes it possible to choose any reasonable mixture.

The final blow at the fracture system surely arrives when the furnaces themselves grade irons by analysis even when they sell them by fracture. This is done, and we think that irons which are graded by analysis should be sold by analysis, for in such cases the form of fracture-examination has now ceased to serve any useful purpose and might be dropped.

This would greatly facilitate the use of machine-cast pig-iron to which reference was made in a recent issue, for it is now coming to be believed that it is preferable to use irons which have not graphitised. The large pig section favours the growth of large flakes, and it is doubtful if these entirely disappear during cupola melting, to the detriment of the resulting casting.

The change, of course, must come slowly, because foundries using machine-cast pig require chemical control, and time is required to train the men both to analyse with accuracy and mix with discretion and commonsense, particularly the latter, for the foundry cannot be run on the lines of a pharmacy dispensing prescriptions.

Pouring Times.

The instinctive association of ideas which occurs in the mind of the foundryman on the mention of the phrase "scientific control" invariably includes the laboratory, test tubes, retorts, balances and microscopes. In reality, such paraphernalia are the least essential features of scientific control in the foundry. Scientific control means little beyond the application of systematic control and the intelligent application of experience. The determination of the pouring time of moulds can be effected with the simplest of scientific impedimenta—the stop watch—and the exercise of strict control of this is a factor in the successful production of castings which is only beginning to attract general attention in the iron foundry. In other branches of the casting industry—for example, in the casting of steel ingots—this is an important feature of the scientific control necessary for the production of uniformly satisfactory castings.

In the iron foundry the importance of the influence of pouring time in improving the standard of quality, soundness, and freedom from defects is deserving of very close attention. Also, from the point of view of the future development of the ironfounding industry this factor is one of special significance. Any systematic control of the pouring time involves similar control of the methods and details of the "gating," features both of which are vital in considerations of the greater mechanisation of foundry procedure.

It is our desire in calling attention to this aspect of scientific control to lay stress on the necessity for accumulating comparative data on the pouring times, their influence over the range of common practical values in all possible types of castings. This is of great importance to the industry, and our British Cast Iron Research Association might add their resources in the further investigation of the influence of this factor on the properties of castings.

XUM

Aluminium Alloy Castings.

An instructive address on aluminium alloy castings was given by Dr. N. F. Budgen before a meeting of the Birmingham, Coventry and West Midlands Branch of the Institute of British Foundrymen, held at the Engineers' Club, Waterloo Street, Birmingham, on Thursday night, December 6. A number of typical aluminium products were on view, and the address was illustrated by lantern slides. In the unavoidable absence of the Branch-President (Mr. F. G. Starr) Mr. D. Wilkinson took the chair.

Dr. Budgen commented on the extraordinary expansion in the use of aluminium during the last few years, which he attributed very largely to the efforts of manufacturers to cheapen transport—railway, marine, road and air, particularly the last two. He said that the applications of aluminium alloys had not, of course, been confined to the demands of transport, since there were to be seen everywhere castings used for a multitude of different purposes. Aluminium castings, although generally so described, were hardly ever of pure aluminium. The alloying elements were usually added to improve the mechanical properties and casting qualities. Pure aluminium was far too soft for use in the form of castings, except for such special purposes as cable connectors and the like, where an addition of other elements would reduce the electrical conductivity to a point at which the casting would not be of service. While there was a great diversity of alloys, many of which had been patented, only a relatively small number was in general commercial use. Hardly any difference in colour distinguished the various aluminium alloys, which rendered it desirable to have as few different compositions in the foundry at one time so as to avoid confusion. Increase in tensile strength, yield point and hardness was generally accompanied by a decrease in elongation and by some sacrifice in corrosion resistance as soon as other elements were added to aluminium. It might be thought that in view of the rapid strides made in the applications of aluminium a proportionately large number of alloys would have been standardised. This, however, was not the case. Actually there were several hundred different named aluminium alloys, all of which were of quite different compositions, but for which there was little justification; and, as a matter of fact, nowadays hardly any of them were generally recognised in the aluminium castings market.

Casting Processes.

Referring to casting processes, Dr. Budgen said there were three types in commercial use at the present time. So far as sand casting was concerned, there was very little difference in the technique when casting aluminium and when casting brass or cast iron. In the case of aluminium alloys it was necessary to use far heavier feeders and risers than with brass. A second process was the permanent mould process, which was of fairly recent origin, and consisted of pouring the metal from a ladle into a cast iron, or a composite cast iron and steel, die or mould. Where that process was applicable he considered it gave quite the best type of casting. The metal was forced to cool very quickly, so that one obtained a very fine grain and dense structure. The third process, which had been exploited a great deal in America, and was now coming into use in this country, was the pressure die-casting of aluminium. In that process the aluminium was forced out of an iron pot into a die under considerable pressure, either by compressed air or by a hand-operated plunger. The two die-casting processes were limited to cases where a large number of identical parts was required. The cost of the die had to be considered so that the process could not be applied where only a few parts were needed. Where only a few castings were required of a certain pattern, or where the casting was very large, the sand-casting process was obligatory. The maximum weight of permanent mould castings was not more than about 30 lbs., and the weight was generally 10 to 15 lbs., or even less. Pressure castings were usually rather smaller still—from 2 to 8 lbs. Machining and polishing were reduced to a minimum in the case of pressure castings, and considerably reduced in the case of permanent mould castings. In the case of sand castings one usually expressed tolerances in eighths and sixteenths of an inch, whereas with permanent moulds one thought of thirty-seconds and sixty-fourths, and with pressure die castings it was a question of a thousandth of an inch. Pressure die casting was especially suitable for castings having thin sections.

Commercial Applications.

As to the fields of application of aluminium alloys, Dr. Budgen said that not all the alloys could be used indiscriminately in the various casting processes. For instance, in the permanent mould process the alloy known as 2L5, containing 13 per cent. zinc and 3 per cent. copper, was not suitable, because the zinc content rendered the alloy very hot short. Almost all the standardised alloys could be successfully used in the sand-casting process. Specially applicable to the permanent mould process were some of the new alloys developed, particularly for pistons and other castings which had to be either very hard or very strong. Such alloys were usually of the duralumin composition or thereabouts. They were heat treatable, and the point about casting them in permanent moulds was that one obtained such a sound and dense structure that it was quite amenable to heat treatment in a reasonable period. Sand castings generally were rather open-grained and coarse in structure, and required a very much longer time for heat treatment effects to take place. For corrosion resistance and malleability silicon alloys were generally preferred. These alloys did not crack in the mould. Castings for domestic pots and pans must not contain zinc or any element which would be poisonous, so that usually the alloys were restricted to about 2½ or 3 per cent. of copper. That percentage had been found to be harmless. A new application of aluminium was to provide the white lines for traffic guidance in streets. As road surfaces might not be quite level and heavy vehicles passed over the lines any other alloy than a silicon alloy would crack. For castings needing to be pressure-tight or leak-proof either a silicon or a copper alloy was suitable. A silicon alloy was preferable from the point of view of corrosion resistance.

The chairman said Dr. Budgen had indicated a number of the applications of aluminium and shown examples revealing the skilful craftsmanship and scientific knowledge necessary to overcome the difficulties inherent in the production of some of those castings. A few years ago it would have been considered impossible to make some of them in aluminium.

Replying to questions, Dr. Budgen said that no one need have any fear now about the disintegration or deterioration of aluminium alloys consisting principally of aluminium.

Dr. Budgen was cordially thanked for his contribution.

Unemployed Iron Workers.

The Iron and Steel Trades' Confederation have appealed to the Scottish branches to subscribe to a fund for providing Christmas boxes for unemployed members. It is officially stated that 30 per cent. of the Scottish members are unemployed, and that great distress exists in districts which are entirely dependent on the iron and steel industry.

Explosion in a Metal Refinery.

Two men were injured in an explosion which occurred in the premises of Messrs. Osborn & Company (Glasgow), Ltd., metal refiners. The men were heating a metal cylinder preparatory to breaking it up when a violent explosion occurred. Both men were severely burned and cut about the face and arms, and were removed to the infirmary. It is thought that water inside the cylinder was responsible for the accident.

Random Shots.

Bitter are the wailings and lamentations that have in the past few weeks gone up to heaven; many the men, the women, and even the little children whose lives have appeared for ever blighted. And why? Because the football competition has ceased to be. Of course, we must consider, on the other hand, how fruitful the topic has been in arguments, both public and private—arguments as to the morality, the legality, etc., etc., of forecasting correctly 69 results out of a possible 100 in the hope of winning 2½d. a week for life, but that does not go far.

* * *

The first and most essential thing to do is for all right-minded persons to set their wits to work and evoke an adequate substitute for the late lamented Football Coupon, Esq. We have by now relegated Cross Words to the Intelligentsia (and our Better Halves on suitable occasions) and General Knowledge to a humble place among the fashion notes, while Picture-Puzzles are hardly meat for strong men. What about it?

* * *

A story told at a public dinner recently is going the rounds, about the Early Christian and the lion. The Early Christian, consonant with the penalties of Early Christianship, was placed in an arena full of lions. The first lion bounded up to him. The Early Christian leant over and whispered to him. The lion looked horrified and loped away.

Another, and yet another, lion was brought in the interests of zoology and carnivorous experiment. Each time the same thing happened. Finally, the Roman Emperor sent for the Early Christian. "What on earth did you say to them?" he asked. "Oh it was quite simple," said the Early Christian. "I just told each one of them that, of course, they would be called upon to say a few words after dinner!" Some people assert that what he said was that there would, of course, be no opportunity of saying a few words after dinner. So you can have it which ever way pleases your fancy.

* * *

The Dialogues of Albert, the Foundry Foreman.

I.

Albert and the Modern Girl.

Albert: Well, young woman, and what do *you* want?

The M.G.: Dear Mr. Foundry Foreman, just let me have a peep round your foundry.

Albert (with a glance at her legs): Can't be done.

The M.G. (seeing his glance): I could put gaiters on.

Albert (with a glance at her face): Can't be done, I tell you, miss.

The M.G.: Well, I think you're very silly. Don't you believe in the Brighter Foundries Movement?

Albert: That's all very well out o' workin' 'ours. My men are 'ere to work.

The M.G.: Oh, but don't you think they would work *ever* so much better if you brought a little brightness into their lives?

Albert: That's true enough, miss, but what they wants isn't the kind o' brightness as you looks at, but the kind o' brightness as you listens to!

* * *

Marksman takes this opportunity of wishing all his readers a joyous Christmas and a prosperous New Year. That their metal may never contain oxide, that their mould may never scab, or their cores get displaced, or, in short, that they may all produce perfect castings and sell them at tip-top prices is his earnest wish for 1929.

Marksman.

Institute of British Foundrymen.

Scottish Section.

At a meeting of the Scottish Branch, held in the Royal Technical College, Glasgow, on Saturday, December 8, Mr. J. Longden, President, in the chair. The President of the Institute, Mr. S. H. Russell, and Mr. T. Makemson, General Secretary, were present.

The CHAIRMAN said that the branch were honoured by the presence of Mr. Russell, who was paying them an official visit in his capacity as President, and he wished to extend to him a very cordial welcome to the Scottish branch.

MR. S. H. RUSSELL said that he was delighted to be able to visit the Scottish branch and to meet the members. He had already had one surprise, and now this was another. He came under the impression that he would have to make a speech at the dinner later in the evening, but found that he was expected to speak three times, and consequently he felt that there was a danger of repeating himself. It was a great pleasure and privilege to be able to meet the members at an ordinary branch meeting; he had already had the pleasure of attending a meeting of the council, and talking over matters of great interest with them.

The chief value of the Institute to the ordinary member was the branch meeting, for that was where the principal work of the Institute was carried on. He appealed to all the members to take a full share in the work of the branch, not only for their own good but also for the benefit of the whole industry. There was an enormous amount of accumulated knowledge in possession of those of our craft, although unfortunately many were unable to express it. Take, for example, the matter of sand and the binding of it together, so that it can resist the weight and pressure of the metal. An engineer would come along and calculate the pressure without any difficulty, but the practical man knows little or nothing about fluid pressure. Nevertheless he puts on the correct weight to hold the mould down. Again, in the case of ramming necessary for a given job, this can be expressed in terms of weight and pressure, but the practical man does it by touch and instinct. The branches are a splendid means of increasing knowledge among the members of the craft, being composed of scientific members and practical men each capable of imparting knowledge to his fellows, and he appealed to all to take part in the discussions. The Scottish was at headquarters regarded as one of the best administered branches, and he was delighted to have been able to be with them at this meeting.

The CHAIRMAN said the branch was much indebted to Mr. Russell for his address. He had pleasure in asking Mr. Russell to present the diploma which was awarded to one of the local members, Mr. Frank Hudson, for the paper he gave last session on "Scottish Moulding Sands."

MR. RUSSELL said that the Institute awarded diplomas, in limited numbers, to the authors of papers of outstanding merit. He briefly outlined the procedure of the literary and awards committee in selecting the recipients of the diploma, and said that any paper which passed such scrutiny must be of a very high standard. It was no small honour to be the recipient of an Institute diploma. He had the greatest possible pleasure in handing this one to Mr. Hudson.

Heat Treatment of Cast Iron.

Dr. J. W. Donaldson, D.Sc., A.I.C., then read a paper entitled "The Heat Treatment of Cast Iron Between 15 deg. C. and 100 deg. C.," illustrated by a large number of lantern slides. This paper was based upon and nearly identical with the French exchange paper, which has already appeared in the issues of October 25 and November 1.

DISCUSSION.

The CHAIRMAN, in opening the discussion, said that they had listened to a very valuable and interesting paper. It caused the practical man to look with new eyes on many matters connected with foundry work. He was much impressed with the enormous amount of detail work involved in preparing such a paper. He thought it would help to make the ordinary man in the foundry realise that everyone had a part to play in contributing to the advancement of the industry. The fact that phosphorus does not decrease the stability of cast iron shed a new light on the usefulness of phosphorus. It was evident that manganese stabilises the metal by increasing the heat resistance of the carbide, but introduced the question of greater oxidation.

MR. J. ARNOTT said he wished to be the first to pay tribute to the value of Dr. Donaldson's work. All the latest text books on metallurgy referred to it as authentic. He was particularly interested to hear Dr. Donaldson say that the greater resistance of perlit was due to the very low silicon, and that the hot mould had nothing to do with it. He was one of those who thought that it was desirable to keep the phosphorus as low as possible, and the results shown had upset him considerably. The manganese results were bewildering, and at present he did not understand them. He had, however, no option but to accept them. He thought that the main problem was how to get uniformity of structure and grain size.

MR. J. CAMERON said he would like to add his tribute to the value of Dr. Donaldson's work. He remembered being at one of the annual conferences when Dr. Donaldson, in collaboration with Professor Campion, gave a paper on this subject. Everybody there thought that they had a piece of real research, and wanted more. Dr. Donaldson had not stopped there, but had continued the work. He would have thought that phosphorus was the last element to be permitted in heat resisting iron. He had recently had to make some castings of heat resisting metal and had met with considerable success, due no doubt to the fact that the silicon had been kept low. Dr. Donaldson had given them a great many figures, but he was only able to digest a few at the time. The paper gave the results of original research work, which was deserving of all praise.

MR. D. SHARPE asked whether Dr. Donaldson from his deductions would recommend castings being made from material requiring 200 hours heating before going into service, or would he recommend working to an analysis coming very near to that and give a preliminary annealing? In the woollen trade they shrank material before use, and he wondered if something similar could be done with cast iron.

Critical Silicon Percentage.

MR. A. CAMPION said that he had no criticism to make of the paper; he had been in close touch with the author during the time he was carrying out the experiments, and any criticism would have been offered then. We wished to emphasise the importance of the results to those engaged in the production of castings for Diesel work, and other purposes where heat resistance and freedom from growth was an essential quality. The silicon was undoubtedly the governing factor, and it should be kept as low as possible. Dr. Donaldson was quite right to draw special attention to the critical point between 1.0 and 1.2 per cent. of silicon. He himself had been aware of this for a long time, and it was with the knowledge of this fact that he had frequently advised people who had difficulty in producing iron with less than 1.0 per cent. silicon to put it up to 1.2 per cent. He was not yet absolutely sure of the exact limits of this critical range, but as far as he had been able to determine it was between about 1.07 and 1.18 per cent. Metal containing silicon between these points was very erratic in its behaviour. In connection with the phosphorus influence, he was very glad to know that Dr. Donaldson had confirmed that exceedingly low phosphorus was not necessary. He had in the past been called over the coals on more than one occasion for stating that a phosphorus content of the hematite order was not only unnecessary, but actually undesirable. He knew from actual working experience that a phosphorus content of approximately 0.5 per cent. gave the best result. He would like to point out that in the case of actual production of castings it was necessary to consider the influence of all the elements together, and not just the influence of one. The properties of cast iron depended upon the resultant of a number of factors. He congratulated Dr. Donaldson upon the excellent work he was doing, and trusted that he would be able to continue for a long time to come.

MR HUDSON asked the author two questions: (1) The results of the phosphorus experiments showed a stabilising effect at the temperatures (450 and 550 deg. C.), to which he had heated the specimens, but supposing they were heated to a higher temperature, say above the critical point, would the stabilising effect still hold good?; (2) equilibrium is shown to result after a certain period of heating, giving stabilisation of the carbide. Would a preliminary annealing at a higher temperature prevent growth when the material is again heated to a lower temperature?

AUTHOR'S REPLY.

DR. DONALDSON replied that the principal points raised in the discussion by the Chairman and Messrs. Arnott, Cameron and Campion centred around the effects of phosphorus, manganese and silicon. He wished to make it quite clear that he did not recommend the use of 1.0 per cent. phosphorus in heat resisting irons, but conditions might arise where such an amount would occur, and the experiments showed it was not detrimental. At one time he considered very low phosphorus was necessary, and he remembered one case where he was in doubt as to whether to allow an increase from 0.5 to 0.7 per cent. in a specification to meet the founders' requirements, but now as a result of his investigations he would not hesitate to do so.

As regards the effect of manganese on carbon decomposition and growth, Higgins had also shown that manganese accelerated growth. There was no doubt that manganese increased the heat resisting properties, while at the same time it increased growth due to oxidation. The theory advanced fully accounted for it, if oxidation was accepted as being a secondary cause of growth.

He was quite convinced there was a critical point as regards silicon somewhere between 1.1 and 1.2 per cent. Hatfield, and Hague and Turner had shown that the precipitation of graphite on solidification was accelerated somewhere about 1.2 per cent. silicon, which tended to confirm this point. His advice was to keep the silicon below this critical point in heat resisting irons, and as far below as possible. In the case of thin sections, the hot mould might be necessary, but hot moulds would never make irons heat-resisting, that depended entirely on low silicon content, although hot-mould iron would no doubt be more homogeneous and uniform.

Mr. Sharpe had asked about a long preliminary annealing. He (Dr. Donaldson) did not think a 200 hour heating necessary for any iron, when a low-silicon, heat-resisting iron might be put into service direct.

Mr. Hudson's questions as to what would happen by heating at temperatures above the critical range, raised entirely new points. At such temperatures different conditions were encountered, and he would refer Mr. Hudson to the work of Andrew and others on growth at high temperatures. He was sure, however, that heating a grey cast iron for any prolonged period above its critical range would render it useless for industrial purposes.

Vote of Thanks.

The CHAIRMAN said that he thought the members would endorse the view that they had listened to a most valuable paper, and he asked them to accord a hearty vote of thanks to the author.

They had with them Mr. Tom Makemson, the general secretary, and he thought that he would like to say a few words to them.

Position of the Institute.

MR. MAKEMSON said he appreciated the opportunity of being with them at the meeting. In looking over the syllabuses of the various branches one was struck by the wide range of subjects covered, and wondered if it would be possible to keep up the supply of so many papers without a lowering of quality. He thought on the whole the quality tended to improve. He desired to say how much the Institute appreciated the papers and lectures presented to the Scottish Section. He mentioned specially the very important series of papers and discussions in the Symposium on Steel Castings just concluded. This, following on a similar series dealing with Diesel engine castings, and to-day's paper by Dr. Donaldson built on the Paris paper, whilst valuable to the Scottish branch were of untold value to the whole foundry industry.

He would like to make reference to the business side of the Institute, as it was in that department his energies were mainly directed. A few years back they were worried about their finances, they had a balance on the wrong side, but an improvement has taken place, and last year they had a credit balance of over £100, and as far as could be seen at present there would be a balance on the right side at the end of this year. The membership was another matter which had received serious attention; last year the register was drastically overhauled, all those who for various reasons had ceased to pay were removed from the list, and the result was a net increase of membership of 93. The Scottish branch had a net gain of 40 members, which was satisfactory, and it remained to be seen if the same result will be obtained this year. He appealed to all who possibly could to transfer from associate membership to full membership, as the more members the Institute had the greater would be the services rendered to the industry. The constitution of the Institute was somewhat different from that of other associations having local branches, the latter ran the branches from headquarters, but it was the reverse in the case of the I.B.F., as the branches through their elected delegates played a very large part in determining the policy of the Council. He wished the branch continued success. There was any amount of accumulated knowledge amongst the members, and the more they joined in the discussion of the papers the more knowledge would they gain.

The CHAIRMAN proposed that the best thanks of the members be given to the President and General Secretary for their presence and addresses.

Newark's Effort to Train the Young Foundryman.

So beneficial are the meetings of the Newark Engineering Society proving to its members that the local employers are offering the scheme that has been launched this season every encouragement. The meetings are being held regularly, and all manner of subjects, relative to the foundry and the materials that are dealt with, are being discussed, and whenever it is possible lantern slides are procured to bring home to the members the importance of the subjects. The meeting held on Monday at the School of Science and Art was attended by 120 members, and Mr. A. Menmuir presided. Two films were exhibited. The first depicted Persia showing how the country had changed under the influence of the development of the most modern of the world's industries. Over 1,000 miles of roads and pipe lines, about 150 miles in length, it was stated, connect the oilfields to the refineries at Abadan, from which seaport, 6,500 miles from England, the huge tank ships brought their cargoes of oil to Swansea. The second film exhibited showed the manufacture of the Morris car from start to finish.

Thanks were expressed by the Chairman for the loan of the films, and it was announced that a lecture had been arranged on "Steel Production," to be given by Mr. Widdowson, of Sheffield, when it was hoped there would be useful discussion on the many knotty problems that were likely to arise.

Future of the Steel Industry.

A hopeful view for the Scottish iron and steel industry was expressed by Mr. W. R. Scott, M.A., Professor of Economics in the University of Glasgow, in a Paper which he read at a meeting of the West of Scotland Iron and Steel Institute on December 14, although he admitted that the struggle to prosperity would be a grim and long one. Much of the product of the industry went for the formation of capital works such as ships, railways and buildings, so that prosperity of the industry really depended on the steady accumulation of capital. He quoted figures which showed that in 1924 the capital savings of the country were 180 million less in purchasing power than in 1907, which meant that in the intervening years the capital savings of the country had declined by 40 per cent. The war had checked the growth of this capital. On the other hand, the exigencies of war had resulted in an increase in the steel plant of Europe, and the consequence was to-day the industry was suffering from an excess of productive capacity in relation to the existing demand. But for the miners' strike and the general strike, the present day position would have been better than it was.

Changes in the distribution of wealth, and attempts to force up the general standard of living before circumstances were ripe for it, made the recovery of the power of accumulating capital wealth more difficult. Recovery, however, was now beginning to make progress, and it was from this direction that one of the surest methods of relief to the industry was already on its way. Professor Scott also saw in the international movement for the lowering of tariff walls to permit freer interchange of goods another factor which would help the steel trade. Freer circulation of goods would mean more shipping, and more shipping would mean a greater demand for steel. There was also the coming relief from rating and railway charges. The third and last factor in the recovery of the trade was what the trade might do for itself. At present the trade was playing for time, the time when there would be sufficient capital to create a demand which would bring all the steel plant into use; just now it was making a courageous bid to tempt what capital there was.

Selling Abroad.

With regard to salesmanship overseas, there had been a satisfactory improvement, but further development was still possible along these lines. The high standard of British goods, and the fact that the best goods were always the cheapest in the end, had to be brought home to the overseas buyer in a way that he would understand. As the Balfour report had stated, the future of the industry depended on its ability to originate new processes and new products. In the next generation there would be great and revolutionary discoveries in steel-making, and it was essential that Great Britain should not be behind in this field. It might be necessary in the near future to face the relocalisation of the iron and steel industries so that the two could work together physically. He expressed the view that with these changes in prospect, a country with moderate sized plants was in a better position to seize opportunities, mere bigness in industry had never impressed him as it seemed to have impressed Americans and certain public officials in this country. The first flush of easy working of new mineral resources abroad was fading, and the West of Scotland had many natural advantages, and it also had the technical skill, the organisation, and the men. These were really the key to the situation, and given these conditions the picture of the future of the industry which emerged—imperfect and blurred as it must be yet—was one that made on the whole for hope rather than gloom.

A NEWLY DISCOVERED MINERAL.—The Ælium Company, of 832, North Spring Street, Los Angeles, California, have placed upon the market a natural mineral, which they have named "Ælium." The claims made for this material are impressive, but, being entirely unsupported by technical data, we await further news before defining them. Samples are available on application.

Small Foundrymen's Conference.

Blacksmiths and ironworkers generally from the small country workshops, representing over 40 Nottinghamshire villages, attended a conference held at the Newark School of Science and Art, over which Mr. B. W. L. Bulkeley presided.

Speaking on "Suitable Machine Equipment for Country Workshops," Mr. W. Dickinson emphasised the particular need at the present time for taking stock of such equipment, owing to the keen competition of to-day, the changing times, and the imminence of the electrification of the countryside. He demonstrated the relative values of hand and power equipment, discussed the principles of layout and the subject of prices. While advocating the necessity of power-driven machinery in country workshops, he advised his audience to use caution in its purchase on the ground that the advent of such equipment in a country workshop would not in itself necessarily succeed in attracting more work. A power-drill and a lathe he regarded now as absolute essentials.

Following the address, those present had an opportunity of inspecting some up-to-date equipment which had been generously loaned for the occasion by Messrs. A. Ransome & Company, of Newark, while a representative of the firm demonstrated its use and answered several questions.

The demonstration of an oil engine, supplied by Messrs. Clayton & Shuttleworth, of Lincoln, proved an interesting and attractive event, as did also an exhibition of steel testing.

Later, a very instructive film showing machinery on a large scale in operation, was screened, and, at the close, Mr. James Barnett, of Plumtree, referred to the value of such a conference. He expressed the hope that as many of his colleagues as possible would take the fullest advantage of the excellent facilities of technical training which were now offered at Newark.

Thanks were accorded Mr. Stanley Jackson for the admirable arrangements made for the comfort of the delegates and for successfully operating the films.

Nottingham Engineers' Annual Dinner.

There was a big gathering of engineers and foundrymen present at the annual dinner of the Nottingham Society of Engineers, held at the Victoria Station Hotel, Nottingham, over which Mr. C. J. Hofton (President) presided.

The toast of "The President" was honoured on the call of the Lord Mayor of Nottingham (Alderman A. R. Atkey), who said that any group of men who had a common basis for work would be failing in their duty to the community if they did not organise themselves so as to be in a position to give co-operative expression to the ideals they had to provide the means to exchange common ideas to the general good, and to weld in the profession that priceless flux of comradeship and companionship. For his lordship to propose that toast was somewhat fitting, because if he had tried to do anything at all it was in the nature of engineering.

In responding, PRESIDENT HOFTON said that though in modesty a society of engineers could not extol its own virtues, it must be said that without engineers the city would be much poorer.

LIEUT.-COLONEL F. RAYNER toasted "The Visitors," and DR. H. SCHOFIELD (Principal of the Loughborough Technical College, and chairman of the East Midlands Branch of the Institution of Mechanical Engineers) replied; and MR. A. HOPKINSON, managing director of Messrs. Hopkinson, Limited, of Huddersfield, also associated himself with the toast.

In submitting "The Council," MR. J. TERRY said it was composed of men who were ever willing to impart their knowledge to the youngest member, so that engineering as a whole should continue to flourish.

MR. G. S. RANGDALE (Chairman of the Council) responded, and said there was no doubt the Council put in a lot of hard work which, though unobtrusive, was beneficial to the Society.

MR. J. CLARKSON toasted "The Kindred Societies," and DR. D. S. ANDERSON (Principal of the Derby College) responded.

The Reclamation and Reconditioning of Foundry Sands.

By W. E. Dennison.

Great Britain, being in general well supplied with sands suitable for foundry purposes, the practice of sand reclamation has been developed to only a relatively small extent, whereas in the United States of America and in various parts of the continent of Europe, the economics of foundry-sand suppliers has necessitated a considerable development of the practice of sand renovation. It can be said that the reclamation of waste sand divides itself into two groups:—(a) the reclamation of waste moulding sands and the utilisation of cleaning room or burnt core sand for moulding-sand purposes, and (b) the reconditioning of used core sand for core-sand purposes. The reclamation of waste or spent sand must be distinguished from sand manufacture, that is, the blending or mixing by mechanical means of two or more grades of sand to obtain a product with physical characteristics which make it suitable for the manufacture of certain types of castings. Such mixing of sands having different percentages of clay substances has long been practised both by sand producers and sand consumers and offers few difficulties. The grains of the various sands mixed have clay coatings of various thicknesses and a mere cutting of the sands is enough treatment to produce a fairly uniform moulding sand.

Influence of Cost.

The reclamation and reconditioning of sand hitherto wasted will undoubtedly progress considerably in this country so soon as the chemical and physical characteristics of the sands come to be better understood. For although most of our foundries are favourably situated for sand supplies, the cost side of the question still provides a large margin for economies to be introduced in this division of foundry costs. Let the founder work out his sand costs, remembering that the charges are not finished with until the waste sand has been permanently eliminated, which in many cases means cartage at his own cost to a dump on land which he has had to buy.

Use of Rational Analysis.

In the past the chief obstacles which have been offered to the scientific manufacture and technical control of moulding sands have been due to the lack of positive methods of analysis. The "feel" of the sand as recognised by the moulder is still to-day the main criterion in judging the qualities of moulding sand. However, in the same manner as the mixing of iron had to be preceded by a thorough understanding of the chemical and physical properties of cast-iron of various compositions and of the composition data as obtained by the analysis of the mixture ingredients (pig-iron, cast-iron scrap, steel scrap, and various ferro-alloys), so has the manufacture of moulding sands from waste or used sands and strong bonded sands or clays to be preceded by a better knowledge of the physical and chemical characteristics of such sands and clays than generally exists at present in the foundry world. Pure chemistry of sands and clays is very complex, but fortunately a somewhat simplified proximate form of composition obtained from what is known as the "rational" analysis is of more value for interpretation of clay and sand properties than is the more tediously-obtained chemical composition. The *rational* analysis gives the percentages of quartz, clay and felspar, while the percentage of hydrated oxide of iron which has a valuable bonding property and which is not ordinarily included in the rational analysis can be given in addition. The best analogy which can be given of the two types of analysis is that of the proximate and ultimate compositions of coal with which most foundrymen are conversant. The simpler proximate form conveys at once much more information regarding the properties of both sands and coal from a practical point of view.

The physical tests which have been introduced in order to provide a more accurate way of judging foundry sands than by appearance and "feel" embrace the measurement of permeability, ramming and mould hardness, strength and sedimentation, all of which are necessarily expressed in some arbitrary unit. Though the standardisation of the methods of applying, and reporting the results of, such physical tests is desirable, it will be realised that so long as a standard is fixed in agreement with a moulding or core sand mixture which is known to give satisfactory results, the exact method of applying and reporting the tests is not all-important.

Sieving Tests.

Sieving tests, made with a standard set of sieves, give very interesting results which, interpreted properly, can be extremely useful in the synthesising of foundry sands. For instance, it has been generally considered in the past that it was essential to have a very fine sand from the view-point of a sieve analysis, that is, a sand free from coarse grains, in order to obtain smooth castings, but it is now known, as the result of research, that the coarse grains which stop on the sieves with mesh up to 100 may be neutralised effectually, in determining the smoothness of a casting, by the fine grains which pass the 300-mesh sieve. The nature and amount of the bond, as well as the preparation of the sand, also govern the surface condition of the casting. These small grains naturally also govern the permeability of the sand, so that it will be seen that the permeability and facing value of a moulding sand are features which are, to a certain extent, mutually exclusive. These remarks presuppose the elimination of specially prepared facing sands, which is the tendency of to-day. The characteristics mentioned, however, make it possible to use comparatively coarse sands for a base in synthesising moulding sand, and the subsequent addition of fine sand and clay in the right proportions provides the correct compromise of strength, permeability, and facing value.

Prepared moulding sands are, or should be, perfect mechanical mixtures of grains of various shapes and sizes and with various degrees of bond, the latter composed of colloidal clayey matter and hydroxides of aluminium and iron, and it will readily be seen that to practise ably the preparation of synthetic moulding sands demands a thorough knowledge of the character and influence of the various ingredients. The cohesiveness of a moulding sand is influenced in no small measure by the percentage of moisture which it contains, and for this reason the tempering of the sand should be carefully controlled.

Moisture Determination Influenced by Carbon Content.

In order to obtain the best possible results in the foundry it is necessary to have a sand with as uniform bond and temper as it is possible to get from day to day. To facilitate the moisture determinations various combinations of electrical instruments have been designed, the moisture being determined by measuring the electrical conductivity of the sand, which increases with the percentage of water. The difference in the nature of the original sands and the carbon content due to coal dust, presents the first difficulty in the fact that the electrical conductivities of the dry sands can vary considerably. For this reason, it is necessary to plot separate curves for each type of sand. This is done by drying at 110 deg. C. a good sample of each sand and measuring its electrical conductivity, thereafter adding up to 10 per cent. of water in stages of 1 per cent., and making for each water content a separate conductivity test. The moisture test is usually carried out in the permeability apparatus, to which a few small modifications have been made. These instruments and others used for the testing of sands were described in an article by Ridsdale.*

* FOUNDRY TRADE JOURNAL of November 3, 1927.

The nature of the bond of a sand can vary considerably in its resistance to permanent dehydration, and it is generally considered that the bond due to the presence of hydroxide of iron is of a more permanent character than that due to clay. The partial destruction of the bond when the molten iron comes into contact with, and is allowed to remain in, the mould until set and cooled will depend on the above-mentioned nature of the bond, and will also vary with the thickness of the casting. Such dehydration or denaturing of the bond is gradual, being greatest in the mould nearest the iron. In order to determine, outside of practice, the relative life of the bond of a sand or clay, a well-selected sample should be heated in a thermostatically-controlled muffle to a temperature of 300 deg. C. for a period of one hour. Tests should then be made for permeability and strength, and the results obtained compared with the results of tests made on the virgin sand or clay. In some cases, the heat treatment can be repeated and valuable indications obtained. The experimenter will often be surprised at the different life values obtained with sands or clays (particularly the latter) which originally possessed quantitively the same bonding power. The temperature of 300 deg. C. is, of course, an arbitrary one, but it may be fairly considered to give an approximation of the mean temperature of that part of the sand of the mould which is dehydrated in practice.

Steps to Safeguard Deterioration.

It is evident that to keep the sand heaps from deteriorating, an equal amount of bond to that which is lost by dehydration must be supplied daily either through the addition of a heavily-bonded virgin sand or a synthetic sand of a similar character which has been prepared from used sand and clay. The latter is usually mixed by adding the "waste" sand, screened to obtain the desired sieve analysis or grain size, to an emulsion of the clay, when the whole is well mixed.

In just the same way as a consignment of pig-iron is not sent to the dump because its analysis is not suitable, so, some time in the future, will it seem extremely unreasonable to dump a barrow-load of moulding or core sand when all it needs is a little reconditioning treatment. Undoubtedly "necessity is the mother of invention," and for this reason various other countries have progressed in the art of sand reclamation much more than we have in this island, but, at the same time, sufficient saving can be realised at home to make it worth our while to study seriously this new branch of foundry technology.

It is no exaggeration to state that, in the United States alone, thousands of pounds have been saved by the foundry trade through the intelligent control of sand mixtures in the last few years. The position of the British to-day in the markets of the world is such that anything they can do to reduce the costs of production is worth serious consideration.

Contributions to Charities.

The following contributions to infirmaries and other Scottish charities have been made during the week:—The employees for Macfarlane, Strang & Company, Limited, Lochburn Iron Works, £212 8s. 2d. The employees of Argus Foundry, Limited, Glasgow, £77 14s. The employees of Albion Motor Car Company, Limited, Scotstoun, £620. The employees of the Summerlee Iron Company, Limited, Coatbridge, £2,238 13s. 8d., including £482 8s. 7d. to Prestongrange Miners' Welfare Society.

Fifty Years a Blacksmith.

Mr. David Wright, who has just died at the age of 81 at his home in Kilsyth, was for over fifty years foreman blacksmith with Messrs. William Baird & Company, Limited, ironmasters.

The Manufacture of High-Quality Cast Iron.*

By Professor B. Osann.

Many founders regard metallurgy and metallography as synonymous terms, but this is a wrong conception. Metallography is an auxiliary science of metallurgy, being on the same footing as analytical chemistry and the physical testing of iron.

In the work that has been done to improve the quality of cast iron, the metallurgical side of the question has not had the attention that it deserves, and this is now being recognised. It is realised, of course, the difficulties with which many foundry managers are faced, due to the fact that papers and articles on metallography have gradually assumed a tremendous compass and are often contradictory; whereas very little if any attention has been paid to what actually occurs in practice.

Added to this is the fact that patents have been granted or filed, and that publicity has confused the issue by, either consciously or unconsciously, making it appear that success is possible only on the lines of this or that discovery, whereas this is in many cases untrue.

It often happens, too, that when such patents are filed, the firms filing them maintain undue secrecy, only publishing what it pleases them to do. It must be confessed that this is a great drawback from the practical and scientific standpoint.

The object of this Paper is to demonstrate that it is not such a very difficult matter to reduce the various processes and ascertained data to a common denominator.

The patent granted to Messrs. Lanz for "Perlit" iron marked the commencement of the period of discovery along the lines of high-quality cast iron. It was a grave error to have granted this patent, which was done during the war, at a time when it was impossible properly to investigate and, if necessary, contest it. After the war, the patent remained undisputed, because at this time every foundry was under-staffed, and in the turmoil of the revolution no one had the time or inclination to trouble about such matters. This criticism is not levelled at Messrs. Diefenthäler and Sipp, and the Lanz firm, but at the Patent Office.

It was known, before the "Perlit" patent was filed, that low silicon and carbon iron gives high strength figures, and workers in this field were in the habit of selecting the chemical composition of cast iron to suit castings for steam- and gas-engine and motor-car cylinders.

The two first editions of the author's text book (1912 and 1913) give tables and data of this kind. Like any cast iron having a tensile strength of more than 11.3 tons/sq. in., cast iron of the high-duty type has a pearlitic structure, that is to say, a structure in which (1) free cementite, and (2) ferrite is excluded, and only pearlite and finely-divided graphite are present.

In these circumstances, the Lanz concern cannot object to anyone who postulates, "I am producing a cast iron exhibiting high strength figures. If such iron exhibits a pearlitic structure, it does so without any assistance from me. I am only doing what I and others have always done."

Maurer and Klingenstein.

In course of time the diagrams of Maurer and Klingenstein appeared, limiting the region of the pearlitic structure, and contributing largely to the elucidation of the question. In his work, Maurer did not vary the wall-thickness, but assumed a wall-thickness of 1¼ in. throughout. Klingenstein did, however, vary the wall-thickness; but it is not possible to obtain the composition of the cast iron direct from his diagram, but only the summation of the silicon and carbon, it being left to the practical man to fix his own figures within this sum.

The fact that the silicon and carbon contents supplement each other in this connection was known before Lanz's patent specification was filed. There is an American paper dealing with the question, published in 1916.[1]

Although, according to Maurer's diagram, an iron containing 3.5 per cent. C and 0.7 per cent. Si exhibits a pearlitic structure, and the same applies to a cast iron containing 2.5 per cent. C and 2 per cent. Si, this does not necessarily imply that the same properties will be obtained whichever of the two compositions is selected.

Krupp and Emmel Irons.

These observations explain how further patents came to be filed, and of which one may only recall the Krupp "Star" cast iron (2.9 per cent. C), and the Emmel cast iron (2.64 per cent. C). In contrast to Lanz (about 3.25 per cent. C), these two processes operate with a lower carbon content and a higher silicon content (1.8 to 2.3 per cent. and 2.4 per cent.), and so give special advantages. In all three processes, however, a pearlitic structure is obtained, with this difference, that with the higher silicon content of the first two processes the pearlite is not lamellar but granular. In regard to Emmel's castings, it is recognised that they are suitable for superheater units which have to withstand a very high pressure, that they do not "pipe," and only shrink very slightly.

The author attributes both of these latter properties to the fact that the irons mentioned are eutectic alloys. In his recent Paper the author took pearlitic cast iron as its starting point, and stated that eutectic alloys, and eutectic alloys only have these properties.[2] Eutectic alloys of this kind also possess good properties apart from those named; they also preclude the formation of coarse lamellar graphite.

Refinement of Graphite.

As was stated in referring to "Perlit" cast iron, this refinement is obtained by properly adjusting the carbon and silicon contents. This is the method used by Lanz, Krupp ("Star" cast iron), Emmel, and also Schüz. There are other ways of bringing about this result, viz., superheating and jarring the liquid metal.

Piwowarsky carried out some tests on superheating cast iron. He found that, due to superheating the molten bath up to 1,500 deg. C., the graphite content falls off, giving place to combined carbon, whilst the residual graphite is fine-grained. Piwowarsky did not, however, give any explanation of the process. Hanemann stepped into the breach by postulating the germ theory. He says: "If one remelts pig-iron, this does not result in all the graphite germs or *nuclei* being dissolved, for *nuclei* remain behind in the liquid iron and form the starting point for crystallisation of the graphite in the solidified state, which crystallisation is based on the dissociation of the cementite. If one destroys the *nuclei* by superheating the iron, the result is that the crystallisation of the graphite results in a fine-grained form uniformly distributed throughout the mass. When the iron is jarred, the *nuclei* are mechanically split up and distributed uniformly in the entire melt, thus achieving the same result.

Hanemann says nothing, however, as to what sort of substances they are, which act as *nuclei*, and how they get into the melt.

Much has been disclosed with regard to refining the graphite by superheating the melt, yet in spite of, or because of this, metallurgists have not arrived at a solid scientific basis. There are still many conflicting opinions on the matter.

One of the explanations given is that the carbon and also the graphite content in pig-iron increase with increasing temperature, both in the blast furnace and in the cupola (*e.g.*, in the Schürmann type of furnace). This is a view that conflicts with the theory of superheating. This opinion also receives confirmation from the fact that no one can properly explain why, at temperatures above 1,500 deg. C., the process is reversed and the quantity of graphite again increases. Some authorities even go so far as to doubt whether this change-point does actually exist.[3]

Practical experience has shown that superheating sometimes fails entirely to achieve its purpose.[4] Such failure cannot simply be disposed of by attributing it to the graphite content in the lining of the container, or by supposing that pig-iron has again got into the ladle. If the *nuclei* are really destroyed at high temperatures, there can be no harm in such minute *nuclei* getting into the iron again.

Another surprising fact is that steel scrap (up to 30 per cent. and probably more) must be added while the iron is being melted, and success would seem to be impossible without taking this precaution.

The same object can be attained without the expensive process of superheating, and in this connection attention is drawn to the difference between kish graphite and solid solution graphite. By this latter, is meant the graphite liberated by dissociation of the cementite in the solidified state. In the same way one can speak of primary and secondary graphite.[5]

It is the kish graphite which causes poor strength, wear and frictional properties which must be present in machine parts that have to satisfy high strength requirements (*cf.* the "Perlit" Iron Patent Specification).

Where do the *nuclei* mentioned by Hanemann come from? They are essentially kish graphite crystals which persist during the operation of remelting. They may, of course, also be segregated phosphide eutectic and manganese sulphide. Where, however, the iron has to meet considerable strength requirements, etc., it is usual to keep these concomitant substances within low limits, or, at least, they ought to be. When one is producing a high-quality cast iron the problem is consequently to see that kish graphite is prevented from forming at the outset. It will then be unnecessary to go to the expense of superheating to destroy the *nuclei*. Endeavours should also be made to obtain *eutectic* graphite, and the composition of the cast iron should be selected accordingly.

In this case there would be no necessity to speak of the subsequent "improvement" or treatment of cast iron.

The question starts with the blast furnace. It is difficult to understand why the blast furnace has not been brought into the discussion, because iron is frequently [in Germany] cast direct from it. Unfortunately, however, very little attention has been paid to the question of the carbon content in pig-iron and cast-iron. It is only in recent years that it has been realised that pig-iron contains much more carbon than is desirable. There is no doubt that this is due to the present tendency to adopt more frequent taps with a higher hearth temperature.

The view generally held hitherto has been that, where the cupola is operated properly, no change takes place in the carbon content, which is not helpful. This statement made in connection with the cupola is certainly untrue, for the carbon content does vary in the cupola, sometimes decreasing and sometimes increasing. The author's son is taking the solution of this problem as his thesis for his final examination, but his work is not yet complete. One fact that clearly emerges from it is that the carbon content is slightly reduced.

According to Morschel, a cast iron containing 2.8 per cent. silicon, which cools with a grey fracture, or, in other words, tends to the formation of graphite; kish graphite crystals separate out from the liquid melt where the carbon content is more than 3.1 per cent., and/or that these crystals are present and inclusive in the metal during

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* Translated from "Die Giesserei."

[1] "Relation of the Silicon to the Total Carbon in Malleable Iron and Hard Cast Iron." "Stahl und Eisen," 1916, p. 943, and Thrasher's diagram given in J. Shaw's A.F.A. paper, 1926. See FOUNDRY TRADE JOURNAL, November 25th, 1926, p. 457.

[2] Osann: Das Lunkern in Beziehung zur eutektischen Zusammensetzung ("Piping in Relation to the Eutectic Composition"), "Giesserei," 1928, No. 5.

[3] Cf. von Kerpely: "Giesserei-Zeitung," 1926, p. 420.

[4] Pinsl (among others), cf. "Giesserei," 1928, p. 281.

[5] American investigators refer to primary graphite as that formed on solidification or immediately after, and to secondary graphite as that formed on subsequent heat-treatment as in the malleable cast iron.—ED.

solidification. It is these graphite crystals which give rise to faulty places in the structure, either indirectly in the form of *nuclei*, as indicated by Hanemann, or directly in the form of extraneous matter.[6] With any cast iron containing 3.75 per cent. carbon, then 3.75 per cent.—3.10 per cent. = 0.65 per cent. of carbon would be present in the form of kish graphite—a considerable amount. It must be remembered, of course, that these values apply only to the composition stated. With a different composition, the eutectic point would be displaced.

In the present position of affairs there must be recourse to experience and observation in practice, which can provide abundant data.[7]

As works manager in a metallurgical works, the author had experience with the charcoal blast furnace, and learnt what charcoal pig-iron meant. Kish graphite occurred in this iron when the furnace was operated at too high a temperature; and it was no uncommon thing for pieces of iron to be pushed through the tuyere into the hearth to reduce the percentage of carbon and the hearth temperature. This kish graphite, which assumed the form of small, deep black crystals (not "scales"), with a velvety sheen, blocked up the gates of the mould, obviously resulting in defective castings. It was no unusual thing to send the moulders home until the trouble was overcome. It was overcome, not by superheating, but, as already stated, by reducing the temperature and consequently reducing the carbon content as well. A particular feature about the operation of the charcoal blast furnace is that the kish graphite is not thrown out, as it is in the coke blast furnace, but covers the surface of the liquid iron, as cream floats on milk.

Another characteristic of charcoal pig-iron was that the structure was the same both with thicker and thinner sections; it was a fine-grained, grey structure of wonderful strength properties, and, despite the light appearance of the fracture, the material was very easy to machine.

This latter characteristic is often (but not always) present in "perlit iron," and here, too, the wall thickness does not cause any very appreciable differences in regard to the size of grain of the graphite.[8]

In the coke blast furnace, kish graphite is segregated in very large quantities both when the metal is being tapped into the trough, and also in the pig-iron ladle and in the blast furnace itself. The latter case occurs in particular when spiegeleisen is being made in the furnace. Kish-graphite is also present in the free state in the structure of foundry pig-iron. Cases have happened where a railway truck was loaded with foundry pig or hematite, and where it was possible to sweep the graphite together with a broom. Every practical foundryman is familiar with the type of pig-iron riddled with cavities, carrying so much kish graphite that it can be removed with a knife.

When operating the basic open-hearth furnace with liquid pig-iron charges the graphite has frequently been removed in shovelfuls from the surface of the iron in the mixer transfer ladle.

One blast-furnace plant existed where the management wished to cast liquid pig direct, and where they did not originally install cupolas but only mixers in the shape of reverberatory furnaces. The result was, however, different from what they expected. It was impossible to cast the liquid pig-iron direct, as the kish graphite which segregated choked up the gates and risers and caused pronounced piping. The management had to pass the liquid pig-iron through the reverberatory furnaces so as to give the kish graphite time to get to the surface and separate out; it was removed partly flying about in the air and partly with the slag.

One might perhaps assume that the graphite was redissolved in the reverberatory furnace, but this is not correct, because if that were so it would certainly have separated out again as soon as cooling occurred, such as is inevitable during the transport to the mould.

It is certain that there was no superheating in this particular case, so that only the time factor can operate. By preventing premature solidification, time was given to the liquid iron to enable the kish graphite to separate mechanically by buoyancy due to its low specific gravity.

In a second case a blast-furnace plant in the Saar region found it possible to cast the liquid pig-iron direct from the blast furnace without the difficulties described. In this particular case, however, the iron had a high percentage of phosphorus.

Experiments have been conducted by the author with liquid spiegeleisen (12 per cent. Mn), in which cooling was considerably retarded by using a large crucible which remained in the furnace for a whole week after the metal was melted, and which was kept hot.[9] It was possible to fill a large beaker with kish graphite, which was present between the slag and the surface of the iron. The pig-iron regulus, when it froze, was so resistant that it could only be broken under a heavy drop hammer. This experiment was confirmed by Adämmer, who had a tup cast on the basis of these tests. A similar result was obtained when treating foundry pig, except that the quantity of kish graphite was less. These tests also cleared up the question of the separation of graphite in the blast furnace.

In all these tests the graphite content in pig-iron was reduced—not because of superheating, but by allowing the iron to stand and considerably retarding cooling, the graphite being reduced on a purely mechanical basis.

In view of these test results, the author published a Paper dealing with external and internal stresses.[10] In this case, an internal stress was set up in the casting due to the separation of the kish graphite. The molecules are not in a state of equilibrium, but, like rings under tension, they try to attain this state. If this tension or stress is removed by forcing out the kish graphite crystals, a cast iron exhibiting excellent strength properties is obtained.

Michel[11] has more recently carried out a research on the carbon content when operating the blast furnace for the production of foundry pig, and refers to a eutectic carbon content of foundry pig. This percentage lies at about 3.2 per cent. when the silicon content is 2 per cent., and at 2.5 per cent. when the silicon content is 4 per cent. The carbon outside this eutectic content is kish graphite, and it is an appreciable amount, *e.g.*, 4.0 peh cent.—3.2 per cent.=0.8 per cent.

Michel ascertained the eutectic carbon content by allowing liquid iron to cool, and pouring out the final residuum and analysing it. This affords a good idea as to how far the diagram of the iron-carbon alloy with the eutectic point 4.2 per cent. carbon (which was used unreservedly up to a short time ago) departs from the actual truth.

And it is certainly not mere chance that steel scrap in the cupola[12] and also the molten bath in the electric furnace can only be carburised up to a definite limit. The eutectic point is reached with 2.7 per cent to 2.9 per cent. carbon, and it is impossible to go further because the iron can dissolve no further carbon.

In the ideal state, "Perlit" iron represents a eutectic alloy in which kish graphite is excluded, and the same remark probably applies to the "Star" cast iron and Emmel iron as well. In the last-named iron, the carbon content is low compared with Lanz "Perlit" iron in conformity with the increased percentage of silicon.

Founders do not yet know the composition of the eutectic cast iron alloys such as are used in practice. There is not *one single alloy*, but a large number, for the different percentages of silicon and phosphorus each have their eutectic carbon content. In order not to complicate the problem too much, it is assumed that the manganese and sulphur contents are the same throughout.

One ought really to form three groups of cast irons having a low, medium and high silicon content, and combine each of them with a low, medium and high phosphorus content. One would then have nine different diagrams.

It is one of the tasks of the research institutes to fill up these gaps. This can be done by using a crucible or by the method followed by Michel. There is also a method which Stead used. He placed under a press a pig-iron "pig" that had practically completely solidified, and pressed out the eutectic alloy which still remained liquid.[13] There is also a means of confirming the author's hypothesis. **Eutectic alloys do not "pipe" and** *vice versa;* so that if an alloy does not "pipe," it is eutectic. "Perlit" iron and Emmel iron exhibit little if any piping, and are therefore eutectic or more or less approximately eutectic alloys.

Eutectic Cast Iron.

All the various methods of producing high-quality cast iron meet at this point, and it is in this sense that the statement made at the commencement of this article is intended, viz.: *All these phenomena must be reduced to a common denominator.*

All processes, whether protected or not, which are carried out in foundry practice for improving the quality of cast iron are unconsciously directed to this point, viz., obtaining a eutectic composition, simply because this has obvious advantages.

The eutectic alloy has the lowest melting point, and runs well because there are no crystals in the mother-liquor, and the liquid melt passes into the solid state without any ancillary agency. A eutectic alloy therefore fills out even the finest contours. After it has cooled, this alloy gives the best strength properties and the best conditions for friction, density and wear, because the molecules are able to arrange themselves undisturbed in the state of equilibrium. There is no possibility of segregation or "piping" occurring, while the shrinkage of castings made in this way is very small. Instead of saying "We must strive to get the eutectic composition," we may also say "the liquid iron must be free from kish graphite."

Practically the same thing is achieved by both methods, although in the latter case only hypereutectic iron is excluded, and one is free to use the hypo-eutectic portion of the diagram. Hypo-eutectic iron pours so badly, however, that every foundry manager tends automatically to avoid this condition. One need only remember the pronouncedly hypo-eutectic iron used for malleable castings and its tendency to cast badly and "pipe," and the point under discussion is at once clear.

Only exceptionally is the carbon content reduced to below 3 per cent., and if it is deliberately reduced, as, for instance in Emmel iron, this is made up by increasing the silicon content, so that the eutectic state is unwittingly reached again.

A few foundries include steel scrap in their mixtures, not only for highly-stressed machine castings, but also for such parts as radiator castings. In this way they obtain a denser structure, as the kish graphite is kept down or excluded altogether.

In endeavouring to get a cast iron free from kish-graphite, one must begin with the blast furnace, i.e., with the coke-fired blast furnace, as both foundry pig-iron and hematite always contain kish graphite because of the high percentage of carbon they contain.

It is known that the carbon content can be regulated by adjusting the temperature and composition of the slag, but these connections call for some elucidation, and founders cannot tell the blast-furnace people that they require a pig-iron containing this or that amount of carbon, but they must take it as it comes. The only thing to do, then, is to separate this kish graphite in the reverberatory furnace or mixer by allowing it to stand (not superheating the iron), or to reduce the percentage of carbon either by burning

[6] Cf. Osann: Garschaumgraphit im Gusseisen (Kish Graphite in Cast Iron), "Stahl und Eisen," 1926, 39.
[7] *Ibid.*
[8] Cf. Maurer and Holzhausen: "Stahl und Eisen," 1927, pp. 1805 to 1927.
[9] Cf. Osann: Ueber langsam erstarrtes Spiegeleuceisen (On Slowly-cooled Spiegel eisen), "Stahl und Eisen," 1910, No. 45.
[10] "Stahl und Eisen," 1913.
[11] Michel: Der Einfluss der Temperatur auf den Kohlenstoffgehalt (Influence of Temperature on the Carbon Content), "Giesserei-Zeitung," 1927, p. 567.
[12] Cf. Osann: Die Aufkohlung von Stahlabfällen im Kuppelofen (Carburisation of Steel Scrap in the Cupola), "Giesserei-Zeitung," 1927, No. 24.
[13] "Stahl und Eisen," 1901, p. 9.

it away in the reverberatory furnace, or keep it down by the addition of steel or wrought-iron scrap to the bath. The latter method is carried out in the cupola.

From experience it can be stated that charcoal iron was a eutectic pig-iron, and that that was why it possessed these good properties, in contrast to coke-smelted pig-iron, whose composition is far removed from the eutectic. This is undoubtedly the explanation of the superiority of charcoal pig-iron.

The temperature in the charcoal blast furnace is much lower than it is in the coke blast furnace, as the fuel is easily ignited and consequently could not be preheated to any extent as it sank down. This fact compels the use of an easily-melted slag in the form of a slag rich in silica and alumina and very viscous, so that it has a low thermal conductivity. The result is that it protects the liquid pig-iron before the latter cools, while at the same time it is impossible for the kish graphite to penetrate upwards through the viscous slag, and it remains floating on the surface of the liquid iron.

In the charcoal furnace, which is arranged to give cast iron direct, the temperature must be accurately adjusted. If it were exceeded, kish would be obtained in the iron, while if the temperature were too low the moulds would not "run" properly, and the result would be a bad casting, which would cost too much to machine or otherwise work up. Added to this was the fact that eutectic pig-iron has the lowest melting point and was the best from an economic standpoint. The chemical composition of the grey pig-iron was as follows: C, 3.4; Si, 2.33; Mn, 0.57; S, 0.019; P, 0.79; and Cu, 0.006 per cent.

This composition deviates considerably from that of Swedish charcoal iron, but it is only necessary to refer to the difference in the phosphorus content to show that in both cases the pig-iron may be a eutectic pig-iron. Anyhow, the composition agrees very closely with that of the Rothehütter pig-iron, even in regard to the percentage of phosphorus.

Supposing, then, it is possible to get from the cupola or the reverberatory furnace an iron similar to this charcoal pig-iron and one possessing this same eutectic composition, one would not need to take any measures to treat it.

It seems desirable to avoid the word "veredeln" (refine, treat, improve), simply because this word has lost so much of its force in industry as to have no real meaning for foundry experts, but merely gives a false impression to the vast public and those who are only commercially trained.

Superheating Liquid Iron.

Undoubtedly Piwowarsky did actually succeed in reducing and refining the graphite, but may not an error creep in due to the fact that the mechanical separation of the kish graphite causes a reduction in the graphite content? This separation can only be carried out with hot iron, and this fact may be interpreted so as to make it appear that it is the superheating and not the time the iron has stood which gives the particular result sought. The fact, too, that the coarse graphite crystals then separate from the structure leads to the impression that the graphite has been refined. Piwowarsky himself refers to the influence of the time factor, his object in superheating the metal being simply to curtail the time required to get the effect sought.

If the author has correctly interpreted these facts, one ought not to speak of superheating the iron, but merely of allowing it to stand, and in that case the old foundry rule of "melt hot and allow the iron to stand" would still hold good.

In the process known as "jarring" cast iron it has been found that this operation can only be performed successfully where the iron is very hot, in which case the success of the operation is apparent at once. This simply means that the kish graphite and the sulphides are assisted in the process of separating, the same result being attained in a minimum of time as is achieved by allowing the iron to stand a long time.

Proposed Methods of Manufacture.

It is now proposed to deal with the methods by which a low-carbon eutectic liquid iron for high-quality castings is most economically obtained in foundry practice. Primarily, one should avoid going below 3.0 per cent. carbon. On the other hand, it is difficult to procure a pig-iron of good quality giving a silicon content of below 1 per cent. in the cast iron.

Choice of Furnace for Melting Cast Iron.

The ideal way of solving the problem is to have a tilting type gas-heated mixer capable of taking liquid pig-iron from the blast furnace, and a similar one for iron from the cupola. The expense involved for heating is more than made up by the fact that all foundry scrap and spoilt castings can be melted up in the same mixer.

If the mixer has an acid lining and is operated so as to get an acid slag, the iron can be satisfactorily superheated, as the acid slag is a bad conductor of heat. As blast-furnace iron has a low sulphur content and practically no sulphur is introduced by the fuel, the result is an ideal low-sulphur iron, the silicon and carbon contents of which may be regulated—the last by melting steel scrap with the charge. Mixers of this kind are, however, only available in exceptional cases; and, generally speaking, only cupolas or reverberatory furnaces can be used.

There is no doubt that the cupola meets the wishes of most foundry managers as being the simplest type of melting apparatus, and the Lanz and Emmel processes show that the desired aim may be achieved with it. It is possible to add 60 per cent., and even 80 per cent. of wrought iron without having to make the coke charge unduly high, *i.e.*, over 14 per cent., and still to obtain a low-sulphur iron of sufficiently high temperature.

Emmel does not use a receiver, and keeps the plane of the tuyeres low to prevent any cooling down of the charge. In the United States it is the usual practice to collect the liquid iron in a tilting type mixer and a ladle in front of the cupola. If the latter can be arranged so that it can be heated, the desired aim may also be achieved in this way.

A powerful enclosed-type blower must, however, be available to enable large volumes of air to be introduced with certainty so as to get a high temperature in the cupola. Fans do not give the desired result.

It is suggested that the use of small sections of plates cut up, *i.e.*, "soft" iron (constructional iron scrap), would probably be advantageous as an addition to the melt instead of steel scrap. Other works use only portions of rails (for the silicon) with considerable success. A high percentage of silicon is always an advantage where large quantities of scrap are used, as it generates heat during combustion. It is advisable to use always the same proportion of steel scrap in the mixture.

In calculating the mixture of the wrought iron and steel, 2.7 per cent. carbon should be added to take care of carburisation.[14]

The receiver may also be heated, this being done either by oil or powdered fuel. The latter is the method adopted by the Ostermann concern, at Laatzen (near Hanover), in conjunction with the jarring process.

To overcome any undue rise in the sulphur content, foundry scrap should be reserved for the less important castings, and the melting process operated exclusively on a pig-iron and good scrap charge. The coke must, of course, be as free from ash and sulphur as possible, and of dense constituency. This last is a very important point.

No doubt current methods of cupola operation are capable of improvement in many respects, although Emmel's process represents a step forward in the right direction. The experience gained in operating the cupola might also be utilised in operating small converters. During the war these latter were run with proportions of up to 90 per cent. wrought-iron scrap, and even to-day they are frequently operated with 40 per cent. steel scrap and only 12 per cent. coke.

[14] Osann: Die Aufkohlung von Stahlabfällen im Kupolofen (Carburisation of Steel Scrap in the Cupola), "Giesserei," 1927, No. 24.

Melting Operations in the Reverberatory Furnace.

As is known, the author is a protagonist of the foundry reverberatory furnace,[15] and technical developments have justified the stand he took inasmuch as many reverberatory furnaces—the electric furnaces also belong to this type—are now installed in shops for producing castings quite apart from their normal use in roll and malleable-iron foundries.

It is true that conditions are still far removed from the time when the reverberatory furnace can universally replace the cupola where it is required to produce low-silicon and low-carbon iron, such as engineering, automobile and locomotive works are now doing in increasing quantities.

Only in cases where fairly large quantities are remelted in the reverberatory furnace can one judge as to the economy or otherwise of this process; for the reverberatory furnace only works more economically than the cupola where large quantities of metal are handled and the furnace is run continuously.

Large Units Suggested.

Again, one can profit by experience in the development of the open-hearth furnace. No one dreams nowadays of making such furnaces of small capacity. Iron foundries ought to aim, similarly, at constructing large capacity reverberatory furnaces, unless, of course, they are in the fortunate position of being able to use for iron castings the same furnaces as they employ for melting steel. This could be done without difficulty, in the same way as it is done with the electric furnace.

The ideal for the foundry would be to use a gas-heated reverberatory furnace, operating on an acid bottom and with a reversible system of firing and utilisation of the waste heat. Similar furnaces are being used at present in conjunction with mechanical charging. This system would satisfy all requirements. The silicon content could be adjusted by burning away the surplus and the carbon content could be treated in the same way, whilst a low-sulphur iron could be ensured by properly selecting the mixture or by desulphurising the iron in the ladle. By suitably arranging the slag, it is possible to work with a high or low oxidation loss (including the carbon loss).

There is one misconception that must be corrected. If really bad scrap is used, then it cannot be treated or refined as we understand improvement in the above sense. An iron of this kind has absorbed oxygen, and the ferrous oxide remains in the iron as a "disease germ" even when the iron is remelted.

It is well known that Ford, at Detroit, takes liquid blast-furnace iron and liquid cupola iron, melted exclusively from foundry and other scrap, and heats it in an electric furnace, where the iron is allowed to mix and—the temperature being raised—to stand.

The very fact that it is possible to adjust the chemical composition of the liquid iron in the reverberatory furnace by allowing it to stand at high temperature, and by making certain additions to it, speaks for its use. This advantage is manifest in the search for the eutectic composition. In this particular respect, the cupola is at a disadvantage.

Schuz Iron.

A method of treating or improving cast iron has been suggested by Schuz[16] (Messrs. Meier and Weichelt), which consists in abruptly quenching a high-silicon cast iron (3.44 per cent. C, 3.38 per cent. Si), the process being similar to that used for obtaining hard cast iron. In conjunction with the high percentage of silicon, however, the structure is not hard, but the result is a fine grey fracture which shows up under the micro-

(*Continued on page* 456.)

[15] Osann: Giessereiflammöfen und ihre Berechnung, "Stahl und Eisen," 1910, No. 36; Osann: Die Verbrennung in Giessereiflammöfen, ibid, 1911, No. 4; Osann: Eine neue Giessereiflammöfenkonstruktion (New Type of Foundry Reverberatory Furnace), "Giesserei," 1923, p. 127; Osann: Giessereiflammöfen, "Giess. Ztg.," 1925; Osann: Giessereiflammöfen, "Stahl und Eisen," 1926, No. 12.

[16] "Stahl und Eisen," 1922, p. 1345; ibid., 1925, p. 144.

The Measurement of the Cupola Air Blast.—II.*

By METER.

The Venturi Nozzle and Orifice Plates—*continued.*

The pressure difference between the flow in the main and the flow at the venturi throat, or the pressure difference on either side of the plate in the case of an orifice plate, is used as a measure of the velocity of flow. The analysis of the case of gaseous fluid flow is based upon considerations of the energy changes in the fluid passing from the main through the constriction. In the strict analysis of these considerations for gaseous fluid flow the case is somewhat complicated by the necessity for taking cognisance of the adiabatic expansion or the change in density consequent upon the change in pressure. The complete formulæ derived involving these considerations is somewhat unwieldy, and simpler formulæ are derived on the assumption that the density of the fluid undergoes no change. Referring to Fig. 1, let:—

A_1 and A_2 = the areas of the inlet and throat of the venturi tube respectively in square feet.

P_1 and P_2 = the absolute pressures at the inlet and throat of the venturi tube respectively in pounds per square foot.

V_1 and V_2 = the velocities at the inlet and throat of the venturi tube respectively in feet per second.

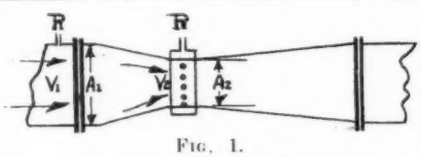
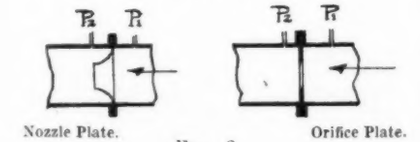


FIG. 1.



Nozzle Plate. Orifice Plate.

FIG. 2.

g = the acceleration due to gravity.

w = the density of air in pounds per cubic foot.

η = the experimental discharge coefficient.

c = a correctional coefficient for the change in density of the fluid.

Then equating the loss in potential energy to the gain in kinetic energy of the fluid passing through the constriction we have the relation:—

$$\frac{P_1-P_2}{W}=\frac{V_2^2-V_1^2}{2g} \quad (1)$$

or

$$V_2^2-V_1^2=\frac{2g}{W}\left(P_1-P_2\right) \quad (2)$$

From the law of continuity we have the relation:—

$$V_2A_2 = V_1A_1$$

or

$$V_2=\frac{V_1A_1}{A_2}$$

By substituting this value of V_2 in equation (2) we now have the relation:—

$$V_1^2\left(\frac{A_1^2}{A_2^2}-1\right)=\frac{2g}{W}\left(P_1-P_2\right) \text{ feet per sec.} \quad (3)$$

or

$$V_1=\frac{1}{\left[\left(\frac{A_1^2}{A_2^2}-1\right)\right]^{\frac{1}{2}}}\times\left[\frac{2g}{W}(P_1-P_2)\right]^{\frac{1}{2}} \quad (4)$$

feet per sec.

The quantity flowing in cub. ft. per sec. Q is therefore:—

$$Q=\eta\left(\frac{A_1A_2}{A_1^2-A_2^2}\right)\times\left[\frac{2g}{W}(P_1-P_2)\right]^{\frac{1}{2}} \quad (5)$$

cub. ft. per sec.

where η is the experimental discharge coefficient.

In foundry practice where the difference in pressure ($P_1 - P_2$) is usually measured in inches of water, the relation in equation (5) becomes:—

$$Q=\eta\left(\frac{A_1A_2}{A_1^2-A_2^2}\right)\times 18{\cdot}23\times\left[\left(\frac{H}{W}\right)\right]^{\frac{1}{2}} \quad (6)$$

where H is the difference in pressure measured in inches of water. The resemblance between this and the pitot tube formula will be noted.

On account of the neglect to take into consideration the change in density the formula in (6) requires a further coefficient to correct for this. This correctional coefficient depends upon values of the term $\left(\frac{A_1A_2}{A_1^2-A_2^2}\right)$ and the ratio of P_1 to P_2 in equation (6). The former term is usually known as the criterion of the venturi tube, and in industrial instruments this criterion or the ratio of A_1 to A_2 is carefully determined by the makers. This may vary from 3 to 1 to 20 to 1, according to the purpose for which the tube is intended, and the values of the correctional coefficient in well-designed tubes vary from 0.94 to 0.97. For the derivation of these coefficients the reader is referred to larger works and original papers on the subject of air measurement.†

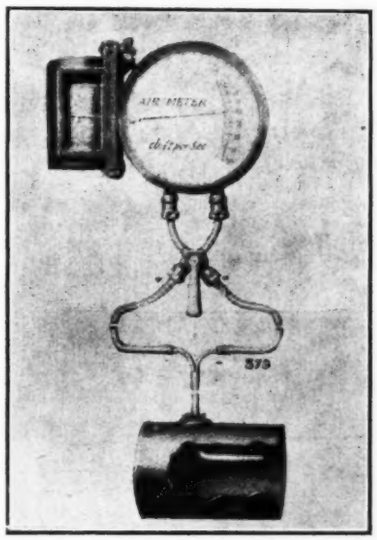


FIG. 3.—DIFFERENTIAL GAUGE AND RECORDER.

The above formula applies to venturi tubes, nozzles and orifices, which latter may be regarded as special cases of the venturi tube. Common types of nozzle and orifice plates are illustrated in Fig. 2.

The discharge coefficient η has been experimentally determined for a wide range of different types of nozzles and orifices. This coefficient is influenced by such features as the thickness of the orifice plates, the condition of the edges, the surface of the nozzle or venturi. In well-designed venturi tubes or nozzles the coefficient is slightly less than unity, being from 0.94 to 0.99, and the various types of orifice plates have coefficients varying from 0.60 to 1.0. This coefficient is constant for the particular tube in well-designed instruments.

In the use of the above formulæ for industrial work it is sufficient to utilise the mean density of air without reference to the moisture content. For accurate and scientific work this is insufficiently accurate, and the moisture content must be taken into consideration. Table I gives the density of pure dry air at various temperatures in lbs. per cub ft.

TABLE I.—*Density of Dry Air at Increasing Temperatures*

Temperature. Deg. C	Density. Lbs. Per cub. ft.	Temperature. Deg. C.	Density. Lbs. Per cub. ft.
0	0.0781	16	0.0737
2	0.0775	18	0.0732
4	0.0770	20	0.0726
6	0.0765	22	0.0721
8	0.0759	24	0.0716
10	0.0754	26	0.0712
12	0.0748	28	0.0708
14	0.0743	30	0.0703

The relation between the density, temperature and pressure of air is given by the following equation:—

$$W = 2.69981\ p/T$$

where: W = density in pounds per cubic foot; p = absolute pressure in pounds per square inch; T = absolute temperature.

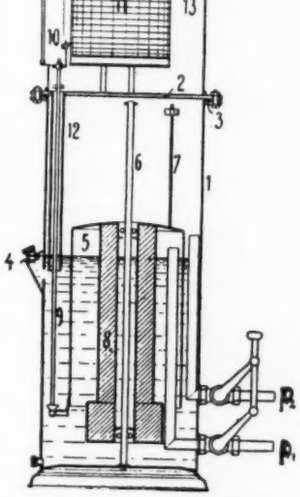


FIG. 4.—SECTIONAL VIEW OF "ARKON" GAS VOLUME RECORDER.

The following additional constants are useful in these calculations:—

1 atmosphere = 2,116.3 lbs. per sq. ft.
1 atmosphere = 14.70 lbs. per sq. in.
1 atmosphere = 404.8 in. of water.
1 atmosphere = 29.95 in. of mercury.
1 atmosphere = 760 mm. of mercury.
Absolute temperature = (459.5 + F deg. Fah.).
= (273 + C deg. Cent.).
Gas constant = C = 53.34 (English).
Universal gas constant = R = 1,530 (English).
= 848 (Metric).
Molecular weight of air = u = 28.95.
Specific heat of air = K = 0.283.
= K_v = 0.170.

In both the pitot tube and venturi or orifice meters the metering of the air flow rests upon the measurement of the pressure difference ($P_1 - P_2$). This pressure difference can be measured in the simplest fashion by the use of two liquid U-tube manometers attached to the respective limbs of the pitot tube or suitably connected to the venturi tube or the pipe line containing the orifice plate or nozzle. The pressure difference can be directly measured by the use of a single U-tube manometer in the manner indicated in Fig. 2, Part 1 of this article. In the application of the pitot tube to the measurement of the cupola air supply the pressure difference is of so small a magnitude that the

* Part I appeared in our issue of September 20, pages 201 and 202.

† (See Appendix to Paper by HODGSON on the Commercial Metering of Air, Gas, and Steam. Proc. Civil Engineers, Vol. ccIv, Part ii, 1916-17).

accuracy of reading the pressure differences is increased by special forms of construction of the manometer tube and the use of special filling liquids. The inclined tube manometer is familiar in the Campion, Clark, and several other similar instruments. The specially-curved inclined tube manometer of Geo. Kent, Limited, provides for still greater accuracy in the reading of small pressure differences. A very ingenious adaptation of the manometer has been devised by Messrs. Geo. Kent, Limited, to enable continuous and visible records to be taken. This construction, known as the balanced manometer, consists of two vessels containing the liquid connected together beneath the level of the liquid and mounted so as to be balanced about a knife edge. Each of the two pressures to be dealt with are introduced into each of the two vessels by suitable flexible connections. The difference in the pressures causes the liquid to be displaced, thus altering the centre of gravity and causing angular movement of the system about the knife edge. This movement is transmitted by a pen and pointer to a chart or scale respectively, thus enabling a visible or continuous record of the differential pressure to be obtained. The scales can be calibrated to read directly in velocity or quantity.

Differential dial gauges of the diaphragm type are also used for this purpose. These have the merit of avoiding the use of liquid in direct reading types of instruments, and depend for their action on the movement of a thin flexible diaphragm dividing two chambers under the influence of the two pressures on either side of the diaphragm. With suitable mechanism this type of instrument can be arranged to provide records and the scales calibrated direct to read in volume per second. Such an instrument is illustrated in Fig. 3. A wide variety of mechanical methods of transmitting the movements of such diaphragms to the indicating and recording mechanism are utilised in the various instruments of different manufacturers.

A careful elaboration of the liquid-filled U-tube manometer is involved in the hydrostatic indicators and recorders constructed by various instrument makers for use with pitot, venturi and orifice plate meters. In this type of instrument the movement of a sealed bell floated in a liquid in a sealed chamber is utilised to measure the pressure differences. The method of operation of this type of instrument will be understood by reference to Fig. 4. Of the two pressures P_1 is led to the underside of the bell and P_2 into the chamber in which the bell floats. The variation in the pressure difference produces vertical movement in the floating bell which is transmitted to the recording mechanism by means of an arm operating through a suitable seal. Suitable arrangements are provided to ensure perpendicular movement in the bell and the records are traced in rectangular co-ordinates upon a chart wound round a clock-driven drum, or in circular co-ordinates on a chart mounted on a clock-driven disc. The scales are generally calibrated to read in cub. ft. per min. direct.

Quite an interesting adaptation of the flow through constricted nozzles is to be found in instruments of the following type. In one construction of this type of instrument known as the rotameter, the air flow is led through a taper tube, containing a top-shaped float which is freely retained in suspension by the upward current of air through the tube erected in a vertical position. The principle upon which this meter operates is very similar to that of the Deacon Waste-Water meter, and in a way is the opposite of the venturi meter. The float is held in suspension in the taper tube by the impact of the fluid, and rises to a position of equilibrium in the tube determined by the velocity of the flow. With any change in the velocity the float takes up a new position of equilibrium in the tube, such that the annular orifice between the float and the tube is sufficient to pass the flow. If the tube is made of transparent material, such as glass, the height of the float is visible and a scale is incorporated in the glass tube calibrated to read directly the quantity of fluid passing. An accuracy $\pm$ 2 per cent. is claimed for the particular instrument known as the rotameter, which is largely ascribed to the construction of the float. The float is so shaped as to be rapidly rotated by the stream of air flowing, and by this means the need for mechanical guides retaining the float in a perpendicular and central position are eliminated. It is necessary to apply corrections for the changes in temperature and pressure of the air stream.

Controlled Paddle or Anemometer.

Anemometers in most forms are indicating meters as opposed to integrating meters and directly only record the pressure due to air currents. The velocity of the air current must be obtained by the culitration of the particular meter which will depend partly upon the laws governing the pressure of moving air on plane surfaces or curved surfaces. Such indicating meters, carefully designed and calibrated, can be made extremely sensitive,

These makers take a variety of forms from that of the simple oscillating gate or paddle suspended in the air stream to the fan-type meters operated by means of a multi-vaned fan rotated by the air stream. The well-known Wilson-Crosby meter is of the former type, arranged to give continuous records of the air flow. This type of instrument has the merit of simplicity in operation and maintenance, robustness of construction so very desirable in instruments for in connection with cupola plant.

A rotary type of anemometer operating through the movement of a multi-vaned fan has found use in the measurement of gas flow in industrial gas works. So far this type of instrument has not been applied to cupola air measurement.

Door Handles and Knockers.

The door handles of the main entrance to a building to-day, as in past times, have frequently a big ring or knocker attached to them. The modern handles are often of great beauty, but those of the past are by no means without artistic value, and an examination of them will clearly show the indebtedness of the modern artist to his brother of earlier days.

The accompanying pictures place before us something like a very small illustrated catalogue of the knockers of a 17th century ironmonger. Not one of the handles shown, though all are of interest, is indicative of much merit. Such is, however, perhaps hardly to be expected, for though some fine metal work is to be found of all periods, artists, generally speaking, took little interest in either design or craftsmanship, in the time when these handles were made. In the following century folk, despite a few great names, appear to have shown a greater dexterity in the handling of a corkscrew than pencil or graver.

The knocker at the top left side is a nice piece of work, showing four elephants' heads with preposterously elongated trunks. That on the right side is dated 1548, the 4 being an interesting survival of the old mediæval 4. Lower down are two bulls' heads. The lower left-hand knocker has in the centre an antelope's head, the right-hand lower knocker having a head near the top and another at the bottom. This knocker is of the 17th century. The measure by the side indicates the size of the handles.

Probably the finest and most striking door handle existing to-day is that known as the Sanctuary knocker on the great door of Durham Cathedral. This fine piece of brasswork has for its main design a great weird-looking face, from the mouth of which depends a double-headed snake as a ring or knocker. Numberless reproductions of this great handle, cast in brass, are sold in large numbers as miniature knockers for bedroom and other doors.

It is a somewhat odd circumstance that only one form of door handle presents any difficulty in its use, the round form which, strangely enough, is that most commonly met with in private houses to-day. Our picture is from a photograph kindly supplied by the Director of the Victoria and Albert Museum.

Antique Door Handles.—Reproduced by Courtesy of the Director of the Victoria and Albert Museum.

Electric-Induction Roll Heaters.

PRE-HEATING DIFFICULTIES SUCCESSFULLY OVERCOME.

It is well known that when rolling hot sheets of tinplates, the rolls will naturally be hotter in the centre of their surface than towards their ends, due to most of the work being carried out in the middle portion and also to the cooling effect of the housings. In order to ensure therefore that the rolls shall be cylindrical during normal rolling they must be turned or ground concave when at the normal air temperature, so that they shall ultimately attain a truly cylindrical form due to expansion. Various methods are in use for bringing up the rolls to the working temperatures, such as the rolling of narrower strip until the rolls have acquired a sufficient temperature to enable wider sheets to be rolled; the use of steam jets or gas flames played on the surface while the rolls are revolving; and the use of electric resistance heaters or radiators surrounding the rolls, in which case the rolls are stationary.

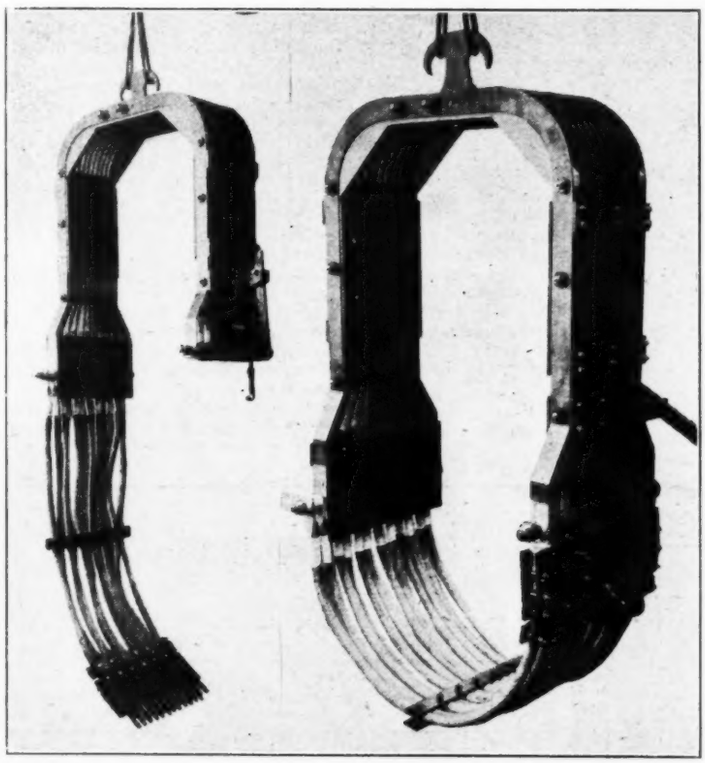


FIG. 1.—ROLL HEATER WITH THE CONNECTING CABLES OPEN.

FIG. 2.—ROLL HEATER WITH THE CONNECTING CABLES CLOSED TO FORM A COIL.

All these methods have very serious disadvantages. In the first case, a great deal of production time is wasted in rolling material which is not wanted; also intense heat is being applied to the surface of a cold roll, which sets up severe expansion stresses at a time when the roll is also being subjected to heavy rolling shocks. The other methods all apply an intense heat to the surface and create a steep temperature gradient between the surface and the centre. This means severe expansion stresses, which tend to start cracks, ultimately resulting in roll breakage; and the intense heat suddenly applied to the chill damages and cracks the surface.

Again, in sheet-rolling processes, where the breaking-down or roughing is done in a separate mill, the finishing rolls must be preheated before production can begin. Also the form of heater used should allow the mills to revolve when it is in use, so that the production of other mills on the same drive is not stopped when the preheating is taking place. An ideal method of heating the rolls would therefore consist of gradually raising the temperature of the rolls by creating heat in the rolls themselves without a steep temperature gradient from the surface to the centre, instead of applying intense heat from the outside, and doing this in a way which would not disturb the arrangements of the mills and their housings, or prevent the other mills revolving for the purpose of roll-turning or production.

This has been achieved by a method of heating rolls which is in use at the Shotton Works of Messrs. John Summers & Sons, Limited, a four-mill equipment being now in regular use. During the last nine months in which the first heater has been in operation no roll breakage has occurred in that mill. The principle of this method of roll heating consists of surrounding the pair of rolls with a coil of wire through which flows an alternating current. This induces currents in the mass of metal contained in the rolls, so generating heat therein.

Fig. 1 shows a roll heater with the connecting cables open, while Fig. 2 shows the same heater with the connections closed to form a coil. As will be seen, the heater consists of strips of copper wound on edge with the undersides connected by flexible leads, the whole being braced together and supported on two rods placed over the rolls. Fig. 3 shows a roll heater being lowered into position, and it will be observed that it clears the screw-down gear. The rolls themselves are covered with a sheet of asbestos cloth, which prevents loss of heat by radiation from the rolls themselves and at the same time protects the roll heater from the heat of the rolls. The heater itself remains comparatively cool, as no heat, as such, is transferred from the heater to the rolls. Fig. 4 shows the heater finally in position and connected up ready for operation. The heater can be put on or taken off within ten minutes, all the connections of the coil being made by tightening one bolt, and none of the permanent mill fixings needs be removed.

It has been found by experience that these roll heaters should be supplied at comparatively low voltage, so that a transformer is normally required stepping down the available pressure to from 100 to 120 volts, the arrangement of the transformer depending on the number of roll heaters in use in one line of mills. For example, if three or six heaters are required, the transformer will be of the 3-phase type, the heaters being connected one or two in each phase; and if four or eight mills are used, then the transformer is of the Scott-connected type, giving a 2-phase system, the heaters being connected two or four in each phase.

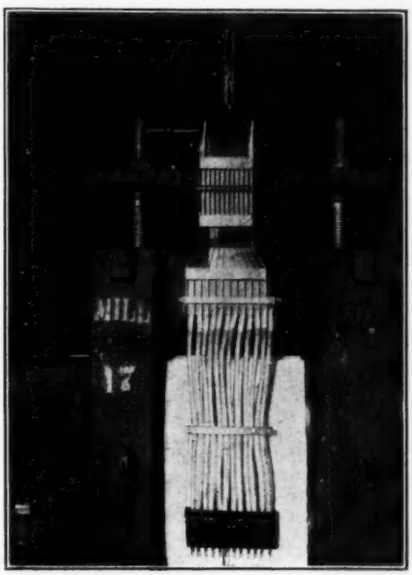


FIG. 3.—ROLL HEATER BEING LOWERED INTO POSITION.

FIG. 4.—HEATER IN FINAL POSITION.

The transformer is preferably placed midway along the mills, and is connected to bus-bars which run under the floor plates. Hand holes are made in the vertical plate alongside the mill bed and opposite the mills, and connecting lugs are pro-

vided in the hand holes in ambush, so that nothing projects into the mill race, which could get damaged. Each heater takes approximately 50 to 60 kw. to raise the temperature of a pair of rolls 42 in. by 30 in. dia. to 300 deg. C. in twelve hours, consuming therefore from 600 to 720 units, the necessary transformer capacity being 100 to 120 k.v.a. The heaters are used on a 50-cycle system, and although they could quite well be used on 40- or 60-cycle systems, they have not yet been developed for use on a 25-cycle system.

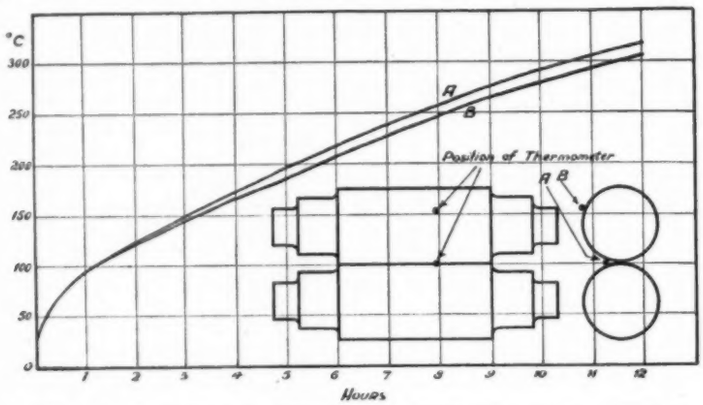


Fig. 5.—Showing the Increase of Temperature on the Surface at the Centre of the Roll.

Fig. 5 shows how the temperature on the surface of the rolls at the centre increases, and it will be noticed that the apparatus can be connected up at 5 p.m. on Sunday evening, and by 5 a.m. on Monday morning the rolls are at the desired rolling temperature. Fig. 6 gives an experimental record of the temperatures at different depths in the roll, and it will be noted that the temperature at the centre rises equally with the surface, and that the temperature gradient from the surface to the centre is small. Fig. 7 shows the temperature variation along the roll, the middle being hotter than the ends, which copies the conditions resulting by the actual rolling process. The temperature circumferentially round the rolls is approximately equal, so that the rolls need not be turned round during the heating process. The heaters themselves do not touch the rolls, and although normally there is no need to turn the rolls round, there is no objection to doing so should work on the other mills necessitate it.

A further use of the heater is that spare rolls can be kept hot, full voltage being applied for bringing them up to temperature, and afterwards a reduced voltage applied for maintaining the temperature, a pair of rolls thus being always ready for use in case of the necessity arising for changing rolls due to a pair being accidentally damaged or broken, or a change in the order for material arising. This considerably shortens the time lost in changing rolls before work can be resumed.

The advantages of this type of heater might be summarised as follows:—(1) The heat is generated in the mass of the rolls themselves, and no excess of temperature exists outside, therefore no expansion stresses are produced to start cracks and damage the chill; (2) the preheating is carried out on Sunday nights or before production starts, and there is no necessity to waste power by turning the rolls round, but should other work necessitate doing so, there is nothing to prevent the rolls being turned round while heating; (3) the heaters are very easily put on and taken off without disturbing the mill; and (4) spare rolls can be kept heated by the same method, reducing the time lost when replacements are necessary.

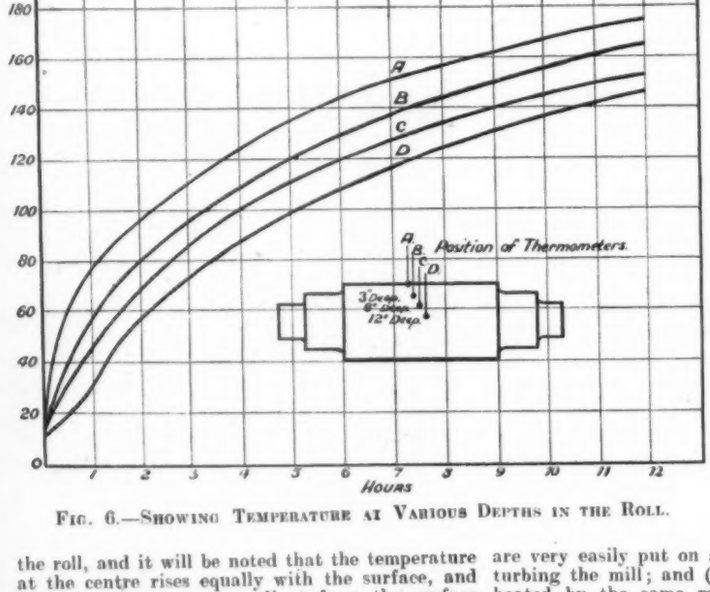


Fig. 6.—Showing Temperature at Various Depths in the Roll.

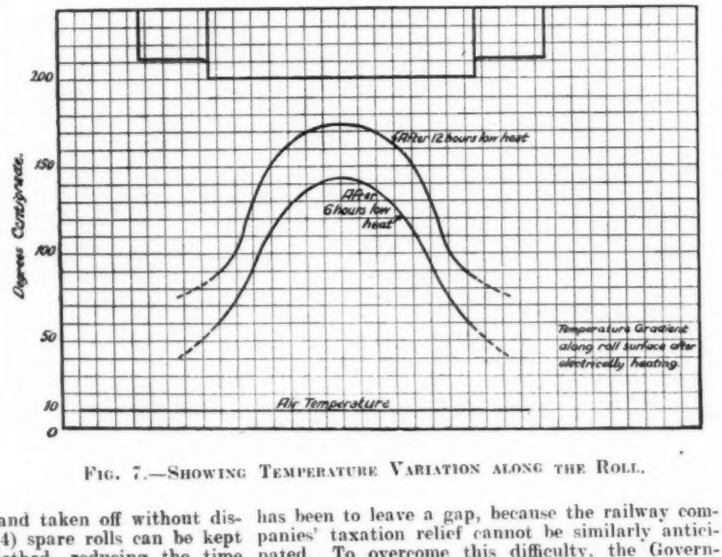


Fig. 7.—Showing Temperature Variation along the Roll.

These roll heaters have been invented by Mr. K. Younghusband (electrical engineer to Messrs. John Summers & Sons, Limited), and are manufactured by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C.2, who have the sole rights of manufacture in this country.

Messrs. John Brown & Company, Limited, Clydebank, have received an order from the L. & N. E. Railway Company to build two twin screw turbine steamers for their Harwich and Hook of Holland service.

De-Rating and Railway Charges.

Percentage Reduction for Certain Goods.

By J. W. Parker, A.M.Inst.T.

As is generally known, the Government's de-rating scheme provides for a reduction in railway freight rates in respect of certain descriptions of coal, together with the raw materials of the iron and steel industry. As originally drawn up, these lower rates were to come into operation in October, 1929, but, following the representations of commercial and trading bodies, the Government decided to anticipate the date by ten months and make the allowance payable from December 1 this year. The foundry trade is perhaps not interested first hand, but it certainly stands to gain in an indirect way by the rebate which is payable in respect of iron ores, lime and limestone in bulk, together with coal when delivered to iron or steel works. For the purposes of this relief, iron and steel works are described as those concerns which consist wholly or mainly of blast furnaces, puddling furnaces, steel furnaces or rolling mills.

In the case of coal, the reduction is by means of a flat rate of 1½d. a ton and 25 per cent. of the remaining carriage charge; in other words, an amount which averages slightly under 30 per cent. of the rail rate. The ores, lime and limestone, etc., have a reduction of 10 per cent. only.

Under the scheme as originally propounded, the relief was to be distributed generally over most rail-borne traffic, but it was found that the concession would be so small as to make no appreciable difference to any of the traffic carried. Upon this being realised, it was decided to concentrate the available benefit where it was most needed. In consequence, the goods ultimately selected to receive the relief are four or five times better off than they would have been under any general scheme of rate reduction.

Under the main programme, the money for the reduced rates is made available through the railway companies being relieved of most of their local taxation, they being under an obligation to pass on to industry the whole of the relief thus gained. Whilst this was quite sound so far as it went, the result of anticipating the scheme by ten months has been to leave a gap, because the railway companies' taxation relief cannot be similarly anticipated. To overcome this difficulty, the Government have been able to make a treasury grant of a fixed sum. Should this amount be more than is required, the remainder will be paid into the main funds next October, but should it fall short, the railway companies have agreed to continue the concessions and make good the difference out of their own pockets. It would thus seem that if the de-rating proposals stimulate the iron and steel trade unduly, the railway companies will suffer a definite loss in their financial resources.

The Government are not directly interested in the administration of this fund, all arrangements being in the hands of the Railway Clearing House and they operate through the individual railway companies in the usual manner.

Foundry Purchasing.—XXX.

By Eric N. Simons.

Organisation of a Modern Stores Department.

It is now proposed to describe the work of storing the goods with a specific account of the methods adopted by a certain large steel foundry. The system outlined will indicate the main lines of procedure, and it can readily be adapted to suit other businesses. Where variations on this scheme are desirable or practised, they will be mentioned later.

All orders issued by the buying department are known to the storekeeper, who receives duplicate copies. These, minus any information that the buyer does not wish the stores to receive, are bound up in loose-leaf books. They have printed on them a space for the insertion of the date on which the goods were received by the stores, and a similar space in which is inserted the department or person to whom they were sent on arrival. The storekeeper thus knows what goods to expect.

Date.	Sender.	Town.	Wagon No.	Description.	Signature.

FIG. 1.—ADVICE NOTES REGISTER.

Any advice notes received in the buying department are sent down each day to the stores. Here they are entered in a book, with pages ruled as in Fig. 1.

This record is necessary in case of loss of advice notes, or dispute in regard to notification of goods expected. Naturally, all the advice notes do not concern the same receiving department or sidings; the stores department has to sort them out. For example, advice notes for the L. M. & S. Railway sidings go to the weighman in charge of that particular sidings. Those for goods that will be delivered by road go to the weighman in charge of the road-delivery weighbridge. In short, each weighman will receive the advice notes for the goods he is likely to receive. By obtaining a signature for any advice note taken away from the stores, and recording the details of the note, a complete history of the incoming consignment is attained, which is of value should reference at some later date be required.

Advice notes are only sent out to weighman when they concern goods that have to be distributed immediately to departments for which they have been ordered. Goods for storage are sent by whichever weighman receives them straight to the stores, who retain the corresponding advice notes. These are entered up in the advice note-book in the customary way.

Recording Arrivals of Goods in Stores.

On the arrival of goods at the stores, the orders are marked off, *i.e.*, the date of arrival is entered

Date received ....
Sent to .....

FIG. 2.—STORES RECORD ON COPY OF ORDER FORM.

in the space provided, and the department to which the goods have been sent is indicated. (See Fig. 2.) "Goods received" notes are then made out and sent to the buying department, with weights and quantities indicated. These notes go forward to the accounting department to be checked over with invoices in due course.

Date.	Order No.	Description.	Sender.	Town.	Department.

FIG. 3.—STORES DAY-BOOK OF ARRIVALS.

Date.	Description.	Sender.	Address.	Department.	Signature of Recipient.

FIG. 5.—NIGHT AND WEEK-END ARRIVALS BOOK.

In addition, all goods arriving at the stores are noted down in a rough book, which serves as a day-to-day record of material arriving. (See Fig. 3.)

The details required for this book are, of course, noted down on the spot, and naturally the books themselves get very dirty and dog's-eared, being subjected to considerable handling. They could not, therefore, be used as a permanent record of stores activities. After the "Goods received" notes have, however, been made out from them, they are used to form the basis of entries in the proper goods received ledger, which is designed as shown in Fig. 4.

In this ledger such details as the truck number, the station, the conditions of delivery (*e.g.*, carriage paid or carriage forward) are inserted, with the object of aiding the work of the traffic department in checking railway carriage and cartage charges. Railway companies are not infallible, and it is no uncommon thing for a consignment of goods that has been forwarded "carriage paid" by the sender to appear in a railway carriage invoice to the consignee as "carriage forward." Since these railway accounts often arrive a long time after the goods have been received and distributed, it is important that a record of consignment arrivals should be kept, so that these invoices can be checked efficiently and without undue delay or labour.

Date.	Description.	Sender.	Address.	Weight.	Railway Rate.	Railway Sheet No.	Truck.	Station.	Dept.

FIG. 4.—STORES ARRIVALS LEDGER.

Receiving Goods after Hours.

The stores clerks and the storekeeper keep, of course, the regulation hours of the establishment; but it often happens that a consignment of goods arrives after they have gone at night, or during the week-end. In order that such deliveries shall not escape proper recording and notice, a "night and week-end" book is kept, with pages designed as in Fig. 5. This book is placed in the watchman's hands, and it is his task to see that the details are inserted.

When the details of their arrival have all been properly entered, the next step is to examine, check, and inspect the goods. Remarks on this side of the stores department's work have already been given in the previous article. In the system under discussion, practice varies very little, if at all, from that of all other stores receiving departments. A special control is, however, kept on bundled goods, *e.g.*, brushes bundled in dozens. These are always rigorously counted, for the

Description.								Location.	Minimum.
Date.	O/No.	Quantity.		Date.	O/No.	Quantity.			
In.	Date.	Out.	For.	Remainder.	In.	Date.	Out.	For.	Remainder.

FIG. 6.—STOCK RECORD CARD.

.....192....

Mr.....

Please let the bearer have .....

Signed.....

For symbol	From symbol

Orderer and supplier fill in symbols as instructed.

FIG. 7.—STORES REQUISITION DOCKET.

simple reason that only too often bundles supposed to contain twelve are found to contain eleven.

When the goods have been finally passed, they are taken into stock and placed in the proper receptacles, bins, lockers, and so forth. Details of the consignment are then entered on stock record cards. (See Fig. 6.)

Goods are then requisitioned for by the departments on forms or dockets as shown in Fig. 7.

In this particular instance, the various departments and classes of work are represented for costing purposes by symbols, and to each symbol corresponds a particular account in the costing department. This system is very intricate, and as its workings are not connected other than indirectly with the work of the stores and purchasing departments, it is needless to describe them in detail. All that need be said, is that the dockets have to bear the symbol of the account for which the materials will be required. Thus, if the goods are to be used in repairing a machine in the tool room, symbol X Y Z may be used. If they are, alternatively, to be used in the tool room in actual production, the symbol might be K Y Z. The first letter of the symbol governs the department; the remaining letters vary according to the character of the work or account, and the subdivisions necessary.

A Set of Cast Bronze Reliefs.

When the Duke of Sermoneta died in 1592 a fine tomb was set over his remains in the Church of St. Pudenziana, in Rome. The accompanying illustration shows a set of cast bronze reliefs from this monument dating from the time of the duke's death.

The reliefs are very Italian in their design, and very characteristic of the period when the monument was made. These castings are of interest, but they make a greater appeal to the craftsman and the student than to the artist, for their beauty is not of the highest order. For our photograph we are indebted to the courtesy of the Director of the Victoria and Albert Museum.

Messrs. Alexander Stephen & Sons, Limited, Linthouse, have received an order to build a cargo steamer of about 9,000 tons dead weight for Messrs. Maclay & Mc Intyre, shipowners, Glasgow. Machinery will be supplied by the builders.

A Canister.

The canister shown in the annexed picture is of the 16th century. The design is not an uncommon one for metal work of that period, though why St. George and his encounter with his astonishing opponent should have been then a favourite subject is not readily apparent.

A noteworthy feature of this form of decoration lies in the fact that at that period it was used not for one surface of an object—a canister, a curfew or whatnot—but exactly the same design is repeated on another surface of the same article. One would have supposed the fertility of the imagination of the designer to have been equal to the work of setting some different form of decoration in place of repeating the first.

An Antique Canister. Reproduced by Courtesy of the Director of the Victoria and Albert Museum.

This canister is of pewter, an alloy which held its own in England for all sorts of purposes for some centuries. Our picture is from a photograph kindly furnished by the Director of the Victoria and Albert Museum. The photograph is somewhat remarkable for the accentuation of the light and shade respectively on the two surfaces shown.

The Manufacture of High-Quality Cast Iron.

(*Continued from page* 450.)

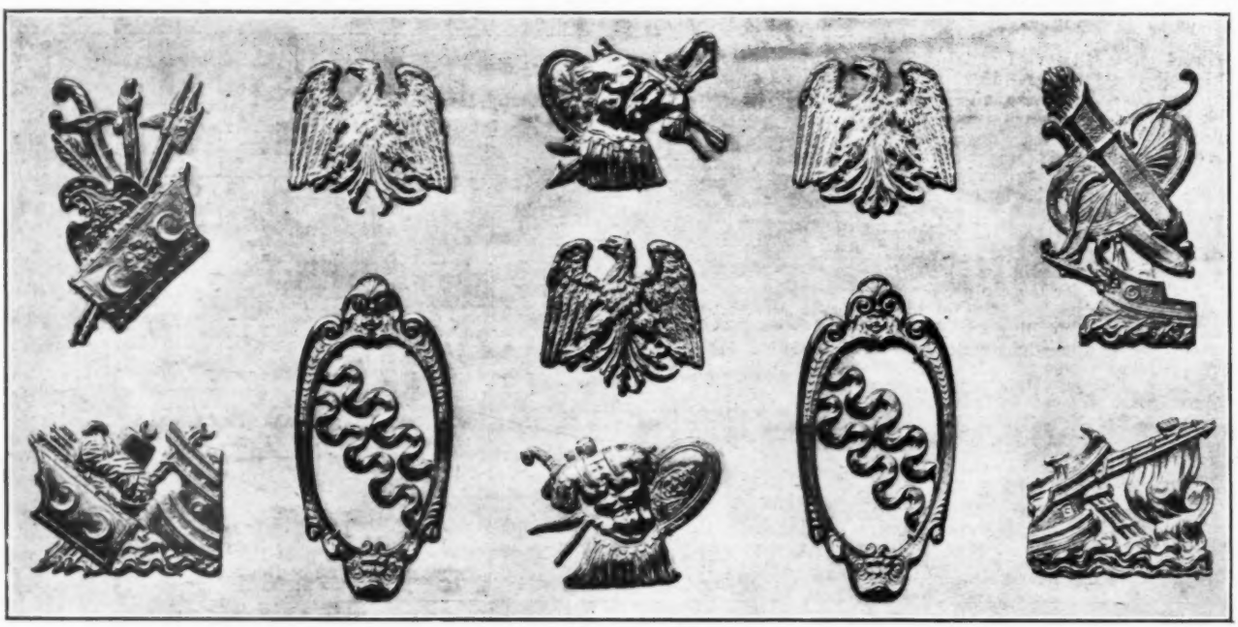
scope as a pure graphite eutectic. This cast iron is used for piston rings, as it possesses very good hardness and frictional properties.

A similar process is already in existence inasmuch as rolls termed semi-hard (especially rough plate rolls) have for a long time now been chill-cast in high-silicon iron. The high percentage of silicon prevents quenching at the periphery of the rolls. Nobody knew, of course, that this produced a eutectic structure and eutectic graphite in this way.

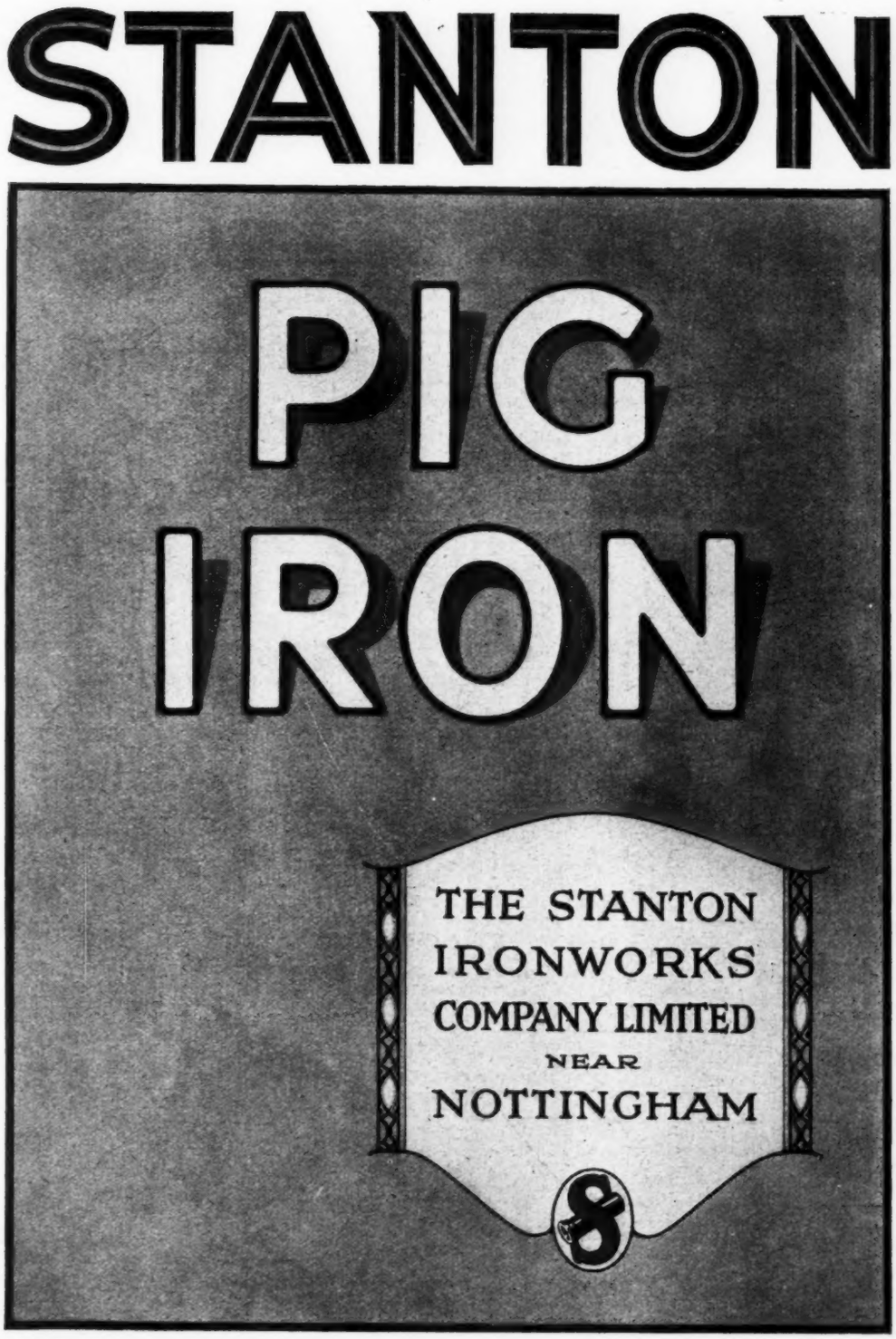
In dealing with the improvement or treatment of cast iron, one must not omit to consider *annealing processes*, which are receiving increased attention seeing that they have given good results, *e.g.*, in turbine castings. Very possibly, these annealing methods will prove much more successful than superheating. In pre-heating the moulds for obtaining "Perlit" castings, Messrs. Lanz produce an effect similar to annealing.

But, after all, Lanz are only repeating a method that dates back to the Middle Ages. In 1450, fifty cast-iron cannon were cast, and a detailed description is available of the moulding and casting process, which shows that the liquid iron (reverberatory-furnace iron) was introduced into pre-heated loam moulds. In a similar way, and probably for thousands of years, paper-thin cast-iron utensils for cooking rice have been cast in China from charcoal pig-iron, the moulds being pre-heated.

Malleable iron represents, too, a cast iron improved by annealing; the iron being freed from internal stresses, as understood in the sense of this Paper, by the cementite being split up and temper carbon being formed. The result is that the molecules have assumed their state of equilibrium and these castings possess excellent strength properties and malleability.



16th Century Bronze Reliefs. Reproduced by Courtesy of the Director of the Victoria and Albert Museum.


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Operation of Open-Hearth Furnaces.

DISCUSSION BY THE AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS.

At a meeting of the Open-Hearth Committee of the American Institute of Mining and Metallurgical Engineers, held on November 15, at Pittsburgh, the following subjects, relating to the operation of open-hearth furnaces, were discussed: (1) Construction of furnaces, (2) quality control, and (3) furnace operation.

Water Cooling of Furnaces.

Various members told of the practice in vogue in their plants with regard to cooling portions of the furnaces by means of water. Doors and frames, bulkheads, bridge walls, ports, valves, etc., were generally listed as being subject to this practice. Opinions differed, however, with regard to cooling of skewbacks. Some plants had experimented with this, with indifferent success. The brickwork did not stand up well and the roof was cut, and in one instance, moisture from the cooling pipe was suggested as the cause. The recirculation of the cooling water was only used in a few instances.

Consumption of water per furnace in 24 hrs. was reported at figures varying from 700,000 galls. to 1,000,000 galls. Water was used at initial temperatures varying from as low as 60 deg. to 115 deg. Fah. Water containing a large amount of suspended matter gave trouble which the use of strainers could not remedy. Hard water helped the formation of scale.

Water cooling along slag lines was reported in one case over a period of about five years. At first there was some difficulty in fusing magnesite against the water-cooled surfaces. This was remedied by applying the magnesite in very small quantities. This practice was said to give a good foundation for the jambs. Saving of brickwork and extension of the life of the back walls by 15 or 20 heats was stated as the principal reason for using coolers at this point. Bricklayers made a much better job in laying up front and back walls under these conditions. It was usually placed about 3 or 4 in. above the highest point at which slag cutting occurred.

Stevens Open-Hearth Furnaces.

A brief description was given of a 25-ton oil-fired acid-lined furnace which had been operating nearly two years under the Stevens arrangement. The furnace is built largely of structural steel, is covered with steel plate to the floor line or above, and is insulated. The covering includes the regenerators and slag pockets. The chambers are under the hearth of the furnace and have 13 ft. depth of chequer brick, with a top area 9 ft. 6 in. sq. The top layers of the brickwork are silica and the lower portion clay. After 500 heats the furnace had to be shut down because the regenerators became clogged up, having openings only 3½ in. sq. At the time of the report, 1,014 heats had been cast, and the superintendent thought the furnace was good for 2,000 heats.

Air supply is by means of a fan with the amount carefully proportioned. Control of this amount is by a Stevens valve. The stack draft is manipulated as is usual on other furnaces. Good operation on furnaces depends in large measure on uniformity of operation, and this was reported to be obtainable on furnaces without the Stevens control. It was claimed that as good fuel economy can be had in regular furnaces, by careful attention to uniform operation, as in the Stevens type.

It was predicted that in three years the present method of operating open-hearth furnaces was likely to be obsolete. The new method took the element of guesswork out of the subject of combustion. Just enough air was used for proper combustion.

The accumulations of slag were reported to be very small—only about 6 in. in each pocket—and about 1 in. of dirt on the chequerwork. The yield was said to be 2 per cent. better, oxides in the slag less by one-third, pig-iron in the charge less by one-third, and loss of castings halved. Former fuel consumption of 44 to 56 galls. to the ton was reported to have been reduced on the first 500 heats to 23.68 galls. This, however, was figured on the net ton of the charge, and not on the gross ton of ingot production. The saving in oil alone was said to be $90 to $100 a day. On this basis the cost of the change-over was figured as covered in 250 working days. Brickwork maintenance costs are as yet not ascertained, but it was said the saving here might reach 50 per cent.

Value of Large Furnaces.

Considerable discussion centred around the ultimate size of open-hearth furnaces. Economically the value of the big furnace was found, both in operating cost and in maintenance of quality. Originally one plant had seven furnaces designed for 105 tons each. These were first operated eight years ago. Gradually these furnaces were charged more heavily, first up to 130 tons and then to 150 tons, at which point six of them are run today. Last year three new furnaces were installed, of 250 tons each, and one of the older furnaces was remodelled to take that same amount. Last April the first heat was tapped from a new 300-ton furnace. The hearth sizes and depth of bath of typical furnaces are shown in Table I.

Table I.—*Bath Sizes in Large Stationary Open-Hearth Furnaces.*

Unit size.	Bath length.	Bath width.	Depth of bath
Tons.	Ft.	Ft.	Ft. in.
150	40	16	2 6
250	45	17	2 10
300	49	19	2 10

A slightly greater yield was reported on the deeper bath, this being due, according to the speaker, to a smaller amount of oxidation, because there is less surface exposed for each ton of steel in the bath. The largest furnace produces 17.3 tons of steel an hour for each 1,000 sq. ft. of hearth area.

Controlling the Quality of Steel Produced.

Methods of taking a sample were discussed, some members questioning the ability of the sample taker to get clear steel without considerable slag in it. This point of view was disposed of by the statement that the slag solidified on the spoon before the steel gets into the spoon, that it remains solid after the steel has been poured out from the spoon, and that the steel samples would clearly show the fact if there were slag inclusions in them.

When adding ferro-manganese and ferro-silicon to the bath, it was recommended adding the ferro-manganese first and then adding the ferro-silicon as soon as the ferro-manganese has melted.

Manufacture of steels containing 0.20 to 0.30 per cent. carbon, 0.70 to 1 per cent. manganese, and 0.10 to 0.15 per cent. sulphur was discussed from the point of view of reducing what many makers find an excessive amount of pipe in the ingots. Several speakers reported having a great deal of piping trouble with steel of this type, although most of those present had had little experience with this particular specification. Keeping the tops of the ingots clean by means of thorough killing of the steel was recommended as a palliative.

Mould Design.

Faulty mould design and occasional cracks from stickers in the mould were charged with a share of the responsibility. But the main cause was reported to be the way the steel is made, with temperature a very large factor. One speaker reported having gone to the use of corrugated moulds, after which he got rid of the trouble. These are almost parallel sided, having only ¼ in. taper. Considerably less scrap is produced. When the interior of an ingot, as shown by microscopic examination, is found to be clean, some of the same ingots occasionally show on the surface a residue of undetermined composition. This was ascribed by one speaker to dirt in the mould. Another speaker said that graphite mould wash, if the graphite happened to be high in ash content, would mark the surface of the ingot. Another speaker said that titanium was being used as a deoxidiser for small ingots, but aluminium was just as good a deoxidiser on the larger sizes. Other contributors to the discussion said they were not using either titanium or aluminium. Spiegeleisen was said to clean up rimming steel satisfactorily, about 1,000 lbs., being added in the furnace on an 80-ton charge, about 25 min. ahead of tapping time, when making steel of 0.08 to 0.12 per cent. carbon.

Discussing what silica content the slag should have when the open-hearth furnace is making steel of 0.08 to 0.11 per cent. carbon, and the best content of FeO and Fe_2O_3 in the slag, a speaker advocated 14 to 19 per cent. silica in the slag, and 16 to 22 per cent. iron oxide, without distinguishing between the two forms. Slag samples should be taken from at least three doors, then mixed and crushed. Passing them over a magnet will remove the iron content and the slag is then ready for analysis. Generally speaking, it is found that a higher lime content in the slag is associated with a higher Fe_2O_3 content, and vice-versa. Determination of FeO was made by analysing for total Fe and for Fe_2O_3, taking the difference as FeO.—("The Iron Age.")

2,000 Years' Old Engine.

Lectures to the foundry and engineering students of Derby are increasing in popularity, and the one given by Mr. Foulks at the Reginald Street Evening Schools on "Steam Locomotive," was most interesting. The lecture was illustrated, and those present could not fail to benefit by the interesting and instructive way in which Mr. Foulks dealt with his subject. The illustrations ranged from a representation of the first steam engine made by Hiero about 2,000 years ago, to the Royal Scot, which has credited so much interest during the past twelve months in the railway world. In addition, screen photographs of types of Continental, American and Canadian engines were exhibited.

At the close a vote of thanks was accorded the lecturer, and a similar compliment was paid to Sir Henry Fowler, who had granted permission for the use of the slides.

Blacking Factory Fire.

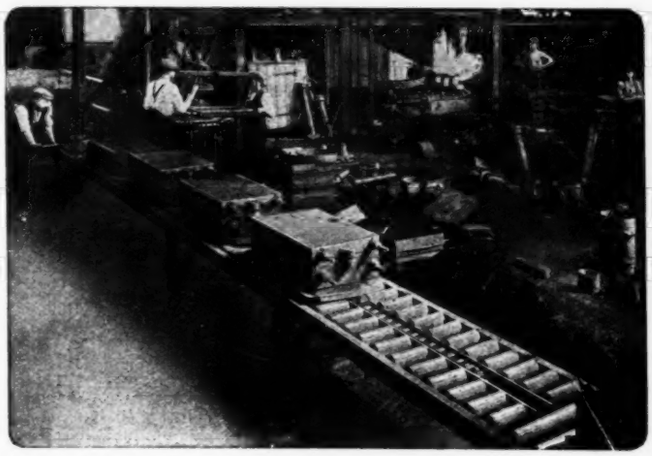
Railway shunters discovered a fire at the iron-founder's blacking factory of Messrs. W. Cumming & Company, Limited, Chesterfield, early on December 9. The works' brigade, under Mr. Winterton, aided by the Chesterfield Fire Brigade, managed to gain control of the flames after four hours, and finally to extinguish them. At first, the damage was thought to have been considerable, but later inspection proved that it was greatly over-estimated, and that fortunately the stock was uninjured.

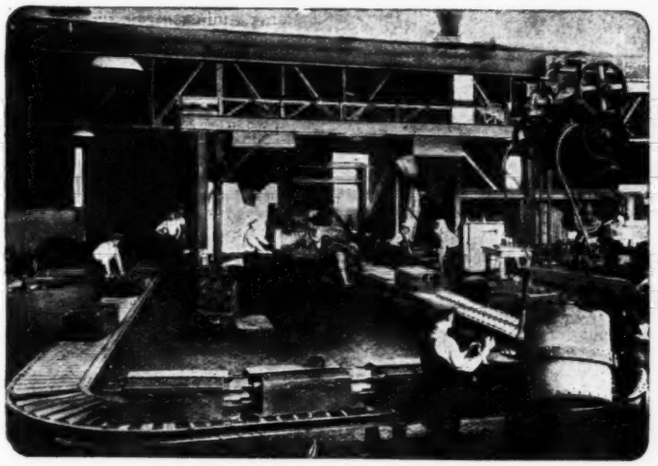
Customers can therefore be supplied as usual, and when the existing stock is exhausted, supplies can be secured from the numerous branch factories of the company. For a short time the normal output of material will be checked, but it is expected that this will be resumed about January 20, 1929.

A New Light Alloys Foundry.

A company has been registered to trade under the name The Verney Light Metals Company, Limited. The foundry is situated at 12, Verney Road, London, S.E.16. The directors are Mr. Henry E. Newton; Mr. H. J. Maybrey, B.A., D.I.C. (Managing); Mr. John A. Newton; and Mr. G. W. Bacon. It is the intention of the company to manufacture light-alloy castings subject to specificational requirements.

XUM





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Trade Talk.

AN ORDER FOR a cargo steamer of 9,000 tons has been placed with Messrs. Alexander Stephen & Sons, Limited, Linthouse, by Messrs. Maclay & McIntyre, Limited, Glasgow. The builders will supply the engines.

THE NORTHUMBERLAND SHIPBUILDING COMPANY, LIMITED, have booked contracts for three large cargo vessels for London and North Country owners. The company, which was only started 14 months ago, has now booked 17 orders.

A CONTRACT FOR metal window frames for the world's largest apartment house, which is being erected in New York, has been secured by Messrs. Williams & Williams, Limited, of Chester. The contract is for 3,500 windows and doors.

MESSRS. RUSTON & HORNSBY, LIMITED, of Lincoln, inform us that at the recent Mysore Industrial Exhibition a gold medal award was secured by a "Ruston" No. 4 universal excavator, and a second gold medal was awarded for a "Ruston" crude-oil road roller.

IT IS ANNOUNCED that a controlling interest in the Ayrshire Dockyard Company, Limited, shipbuilders, Irvine, has been acquired by Sir James Lithgow and Mr. Henry Lithgow, of Messrs. Lithgows, Limited, Port Glasgow, acting for themselves and not for their firm. The Irvine yard has been closed since July last.

AT THE Hotel Metropole, London, on December 11, a dinner was given by Messrs. R. A. Lister & Company, Limited, agricultural and electrical engineers and ironfounders, of Dursley, in connection with the Smithfield Show. Mr. C. Percy Lister was in the chair. Mr. Frank Hodges, who was the principal guest, in proposing the toast of "British Industry," emphasised the value and need of co-operation in industry.

MESSRS. LARRINAGA & COMPANY, LIMITED, Liverpool, have placed with Messrs. Lithgows, Limited, Port Glasgow, orders for three cargo steamers, each of about 9,000 tons deadweight, and they have purchased a similar vessel which is being built by Messrs. Robert Duncan & Company, Limited, Port Glasgow. For these four vessels the engines are being supplied by Messrs. David Rowan & Company, Limited, Glasgow.

THE SECRETARY OF the West Australian Manganese Company has received a letter from Japan asking for samples and an analysis of the company's ores. The company, however, is not yet in a position to supply cargoes in bulk. The letter is apparently a sequel to the big contract for the supply of iron ore from Yampi Sound to Japan. Japan is also reported to be negotiating for 700,000 tons of ore from Blenheim (New Zealand). If, as expected, the negotiations are completed, Japan will have a big hold on the output of iron ore in the southern hemisphere.

WAGES IN THE engineering trade were under consideration recently by a joint committee representing the unions, which sat in conference at Birmingham. It is understood that a further demand is to be made for an increase in the rates of wages, the main question to be decided being whether the claim should be on behalf of the industry as a whole or should be pursued by sections. It is argued that wages in prosperous branches of engineering are dragged down by the depression which persists in other branches. The joint committee completed the drafting of a report for presentation to a general conference of the 47 engineering unions next month.

THE LONDON POWER COMPANY have placed orders for two turbo-alternators for their new power station at Battersea. With the house-service alternators, each will have a maximum continuous rating of 67,250 kw. (90,000 h.p.). One of the turbo-alternators has been ordered from the British Thomson-Houston Company, Limited, Rugby, and the other from the Metropolitan-Vickers Electrical Company, Limited, Manchester. They are the largest sets yet ordered in Great Britain, and are designed for high steam conditions, 570 lbs. per sq. in. gauge pressure, and a total steam temperature of 850 degrees Fahr., with feed-heating system incorporated. The alternators will be wound for 11,000 volts, three-phase, 50 cycles.

THE UNDERFEED STOKER COMPANY, LIMITED, write as follows:—"On November 14 we sent you a notice, the first paragraph of which read:—'The Underfeed Stoker Company, Limited, announce that they have entered into arrangements with Combustion Engineering Corporation, of New York, and the Société Anonyme des Foyers Automatiques, of France, whereby they are licensed to sell throughout their respective territories the new 'L' type travelling grate stoker, designed and patented by the U.S. Company.' It appears that the abbreviation 'U.S. Co.' was taken, at least in one instance, to mean 'United States Company,' whereas it was meant to indicate 'Underfeed Stoker Company,' which is an English concern."

A MEETING OF THE European Union of Zinc Producers, attended by British, German, French and Polish delegates, was held in Brussels on December 11. It was decided to prolong the existing agreement until June 30, and to draw up a new agreement providing for the control of production, including a reduction of output, on January 1 next. This agreement requires ratification in the near future by the directors of the companies concerned. The system of control is established in agreement with all the principal oversea producers of zinc, who for their part have given corresponding undertakings with regard to their exports of zinc to Europe. It was also decided to review the situation periodically, with a view to maintaining the balance between the production and European consumption of zinc.

INTERNATIONAL COMBUSTION, LIMITED, Africa House, Kingsway, London, W.C.2, state that their American associates, the Combustion Engineering Corporation, have obtained orders for the following equipment:—Lopulco pulverised fuel storage system, complete with air heater, fin-tube furnace and settings and boiler of 46,000 lbs. evaporation, for the Mead Pulp & Paper Company, Chillicothe; four Raymond 15-ton six-roller mills, for the Ford Motor Company, Fordson; three Lopulco pulverised-fuel storage systems, complete with fin-tube furnaces, water screens and settings, and three boilers, each of 27,500 lbs. evaporation, for the Dupont Rayon Company, Waynesboro; two steam generators of 1,800 lbs. pressure per sq. in., for the Philip Carey Company, Lockland. This last order represents the highest boiler pressure so far selected for the United States. The company's French associates, the Société des Foyers Automatiques, of Paris, have received an order from Establisements Gillet, for their works at Villeurbanne, for Lopulco pulverised fuel equipment for two boilers, each of 3,750 sq. ft., complete with two 4-ton Raymond roller mills, raw coal-handling equipment, combustion chambers lined with Murray fin tubes, water screens and air heaters.

A PLEA for the safeguarding of the iron and steel industry was put forward by Lord Melchett in the course of an address at a meeting at Manchester recently under the auspices of the Empire Industries Association. Unemployment, he said, could be alleviated to the extent of 120,000 men in the coal, iron and steel and similar industries if we were not importing foreign products at the rate of £3,000,000 a year. National defence must transcend any economic theory, and it was unthinkable that we should allow such a key industry to lapse. He did not wish to exaggerate, or to represent the British steel industry as mortally stricken. But its present condition placed the country in a dangerous state. Reasons for the condition of the industry, he continued, were undoubtedly largely to be found in the industry itself. It had fallen into arrears. Works were situated in the wrong centres; plants were obsolescent; there was great duplication and a want of central control. The remodelling of this industry was one of the most urgent needs of the time, and it was impossible to effect such a remodelling without some form of security against the violent competition to which the industry was now subjected. Unless the industry bound itself to such a re-establishment on a modern basis, he failed to see what its future was to be.

Contracts Open.

Blackburn, January 12.—Iron and steel stores, for the Corporation. Mr. H. M. Webb, borough and water engineer, Town Hall, Blackburn.

Cairo, January 15.—White metal bushes, for the Egyptian State Railways. The Chief Inspecting Engineer, 41, Tothill Street, London, S.W.1.

London, N., January 18.—Iron and steel stores, for the Islington Borough Council. Mr. C. G. E. Fletcher, town clerk, Municipal Buildings, Upper Street, N.1.

Johannesburg, January 17.—Air compressor, arc welding set, electrically-driven railway wheel lathe, motor-driven foundry sand and loam mill, motor-driven foundry rattler and motor-driven stone-crushing machine, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7226.)

Johannesburg, January 31.—85-ft. electrically-driven locomotive turntable, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference A.X. 7253.)

London, W.C., January 7.—Suction hopper dredgers, for the Department of Public Works, N.S.W. The Department of Overseas Trade. (Reference A.X. 7196.)

Stoke-on-Trent, January 16.—Air compressor, for the Corporation. The City Electrical Engineer, St. George's Chambers, Kingsway, Stoke-on-Trent. (Fee, £2, non-returnable.)

New Companies.

Vane's Engines, Limited.—Capital £100 in 10s. shares. Directors: R. T. Morgan, 129, Minories, London, E.; and F. B. Vane.

Improved Gears, Limited, 404-406, Abbey House, Victoria Street, London, S.W.—Capital, £10,000. Directors: W. G. Wilson and J. D. Siddeley.

Byfield Ironstone Company, Limited.—Capital £1,600. Directors: J. Tredwell, Mrs. E. Tredwell and C. Tredwell, Bacon's House, Finnen, near Buckingham.

A. Marshall & Company, Limited, 51, Wicker Lane, Sheffield.—Capital £1,000. Stainless steel tube and hollow-ware manufacturers, etc. Director: A Marshall.

London Warming Company, Limited.—Capital £100. Manufacturers of and dealers in stoves, etc. Solicitors: Herbert Oppenheimer, Nathan & Vandyk, 1, Finsbury Square, London, E.C.

Wyndham's Marine Patents (1928), Limited, Cambrian Buildings, Bute Docks, Cardiff.—Capital £150,000. Engineers, machinery manufacturers, etc. Directors: Sir T. G. Jones, S. J. Till and W. F. Lloyd.

Tongue & Locker, Limited, Grove Lane Tube and Moulding Works, Grove Lane, Smethwick.—Capital £7,500. Brass and iron founders, etc. Directors: C. E. Tongue, A. A., H. H., W. W., and Miss M. M. A. Tongue.

Thomas Try, Limited, 37, Great Pulteney Street, London, W.—Capital £1,000 in 10s. shares, to acquire plant for forming or depositing metals by chemical, electrical or other processes, etc. Directors: Sir Alfred M. Smith, P. Richardson and H. Lovelock.

Reports and Dividends.

Consett Iron Company, Limited.—No interim dividend.

Petters, Limited.—Interim dividend on the 7½ per cent. cumulative preference shares, less tax.

Richard Thomas & Company, Limited.—Profit, £242,728; debenture interest, loans, etc., £132,441; depreciation and special expenditure, £67,181; brought in, £189,747; carried forward, £232,852.

Cleveland Bridge and Engineering Company, Limited.—Net profit, £25,705; brought forward, £7,680; final dividend of 3½ per cent. on the ordinary shares, making 6 per cent., tax free: to reserve, £5,000; carried forward, £7,476.

Walter Somers, Limited.—Loss for year of £22,818, after allowing £11,268 for the debenture service and £17,224 for depreciation, which, together with the preference dividend of £229, is added to the accumulated debit on profit and loss account, raising it to £226,162.

Shotts Iron Company, Limited.—Balance at credit of profit and loss account, after providing for debenture interest and transferring £70,000 from reserve, £2,949; brought forward, £42,847; dividend of 5 per cent. on the preference and second preference shares, less tax, £5,444; carried forward, £40,352.

Dunderland Iron Ore Company, Limited.—In their report for 1927 the directors state that the expenditure during the year was met out of the proceeds of further issues at par of first mortgage debenture stock, the amount issued at December 31, 1927, being £66,350. Since that date the balance of the amount authorised—namely, £100,000—has been issued and expended. For the purpose of providing further working capital now required, the directors propose to create a further £100,000 of first mortgage debenture stock, ranking pari passu with the existing stock. Production was commenced in May, 1928, and the output to the end of October was approximately 30,000 tons of concentrate. The starting-up of the plant disclosed various difficulties and defects, and certain alterations and modifications are under consideration.

Staveley Company Active.

All four blast furnaces at the Devonshire Works, Derbyshire, of the Staveley Coal & Iron Company, Limited, are now in commission, and there is every prospect of a long period of good employment both at the blast-furnace plant and in the associated foundries. No. 2 furnace has just been relighted following a stoppage for repairs. Not since the early part of January have the whole of the four furnaces been in operation at one time. In a message to the workmen and staff of the company, the general manager, Mr. C. E. Whitehead, states that stocks are at a minimum. Records were made on nearly all the installations at the Devonshire works for 1927-28.

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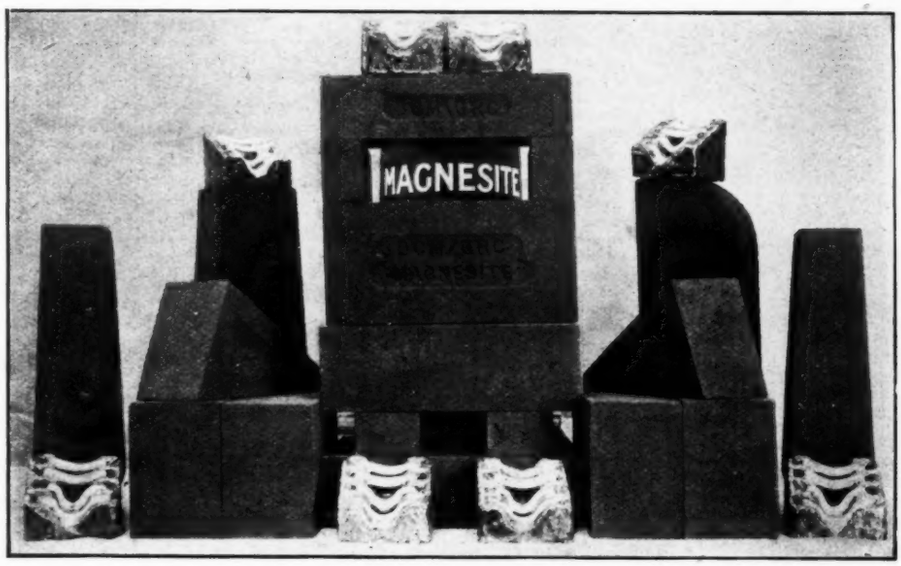

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—The pre-holiday period at the year's close is invariably a quiet time for business in this centre of the iron industry, and, although furnace outputs on Tees-side are moving off satisfactorily in fulfilment of contracts, no arrangements have been yet announced for putting additional plants into operation in the New Year. That such a movement may, however, become necessary is firmly anticipated by the Cleveland ironmasters, reserve stocks having been reduced to a very low level, and an early expansion of demand in the next few months would create an awkward situation for both makers and consumers. The position may be more clearly explained by ascertained estimates showing that in the past two months orders for 80 new ships, aggregating half a million tons, have been placed with shipbuilders on the North-East Coast, and these orders carry with them the assurance of busier times for foundries, engineers and iron and steel manufacturers. Thus, the Cleveland ironmasters can comfortably await developments, and meantime maintain quotations at the old levels, as follow:—No. 1 Cleveland foundry iron, 68s. 6d. per ton; No. 3 G.M.B., 66s.; No. 4 foundry, 65s.; No. 4 forge, 64s. 6d. per ton.

Conditions in the East Coast hematite market continue the improvement previously noted in this branch of the industry, and it is already evident that the prospective restarting of two Middlesbrough hematite furnaces at the beginning of the New Year will be amply justified, as there is an actual scarcity at the moment. Several of the makers are having to turn orders away, as they are unable to give prompt delivery. Prices are consequently firmer, with 71s. per ton quoted for mixed numbers and 6d. extra for No. 1 quality. On the North-West Coast Bessemer mixed numbers are now being quoted at 70s. 6d. to 71s. per ton at works.

LANCASHIRE.—A very limited volume of business is reported in the local markets for foundry pig, few transactions coming under notice at about the following figures:—Derbyshire No. 3, 67s. 6d.; Staffordshire, 67s. to 67s. 6d.; and Scotch brands, 87s. 6d. to 90s., all per ton delivered locally.

THE MIDLANDS.—Due to seasonal reasons, business in this section of the local markets continues quiet, with prices about stationary, as follow:—Northamptonshire, 55s. 6d. to 56s.; Derbyshire, from 59s. to 60s.; and Staffordshire at 60s., f.o.t., with Scotch offered at 89s. to 90s., delivered local stations.

SCOTLAND.—In this area competition is very keen for any business offered, and one or two consumers are taking a little more interest in the forward position, no doubt realising that prices are much more likely to move up than down. Meanwhile, quotations are unchanged on the basis of 70s. for No. 3 foundry, f.o.t. furnaces.

Finished Iron.

The only works which are anything like reasonably occupied in the Black Country are those making marked bars and the better grades of iron. At the present moment they are fairly actively employed, and have no difficulty in maintaining the price of £12 for marked iron. The position of crown and the cheaper irons remains very unsatisfactory indeed, and the local works are experiencing very much competition from works outside the district. In face of the paucity of business and the strong competition, prices remain very low, and £9 to £9 5s. is the figure now being asked for crown bars, and about £8 12s. 6d. for nut and bolt iron.

Scrap.

With a rather better outlook now developed in the heavy industries, there has been a corresponding improvement in demand for scrap metals, and in the Midlands some fairly good orders for cast machinery material have been booked at 65s. per ton, with light qualities quoted at 66s., both delivered at works. In Scotland, however, trade continues slack, with prices unchanged, machinery cast scrap being still quoted at between 65s. and 66s., with heavy ordinary, suitable for foundries, 60s. to 61s., and light cast iron 57s. 6d. to 58s., all per ton delivered f.o.t. consumers' works.

Steel.

In the Sheffield market there is a noticeable slowing down of business. The transactions in acid billets are few and unimportant, and basic billets are in smaller request than of late. Wire rods are moderately active. Prices are unchanged. Acid open-hearth steel production is falling rapidly, but most of the basic steel plants are very well employed. In the tinplate market makers are holding fairly well to quotations, as follow:—Coke tinplates, 18s. to 18s. 1½d. basis for approved specifications, net cash, f.o.b. Wales.

Metals.

Copper.—Transactions in warrant copper of late have been on a diminished scale, but quotations on the whole continue firm and steady, with little apparent probability of a serious reaction in the near future. Demand from consumers on the whole has been comparatively limited, and, although in some quarters it is still thought that the price of electrolytic copper may be raised, such a move, it seems, need not be feared, at any rate at present.

Closing quotations are :—

Cash.—Thursday, £68 5s. to £68 6s. 3d.; Friday, £68 3s. 9d. to £68 5s.; Monday, £68 8s. 9d. to £68 10s.; Tuesday, £68 16s. 3d. to £68 17s. 6d.; Wednesday, £68 17s. 6d. to £69.

Three Months.—Thursday, £68 7s. 6d. to £68 10s.; Friday, £68 7s. 6d. to £68 8s. 9d.; Monday, £68 8s. 9d. to £68 10s.; Tuesday, £68 11s. 3d. to £68 12s. 6d.; Wednesday, £68 12s. 6d. to £68 15s.

Tin.—Rather widely fluctuating values have been the rule in standard tin during the week current, although good rallies were noted after hours at midweek, when new support was attracted. After the recent big rise a reaction was not surprising, especially when it is remembered that statistics for last month show another increase in the visible supply. As long as speculative support continues, prices may hold and even advance, but if this mainstay is withdrawn prices are certain to fall.

Official closing prices :—

Cash.—Thursday, £226 7s. 6d. to £226 12s. 6d.; Friday, £224 5s. to £224 7s. 6d.; Monday, £224 10s. to £224 15s.; Tuesday, £224 17s. 6d. to £225; Wednesday, £224 5s. to £224 10s.

Three Months.—Thursday, £223 15s. to £224; Friday, £222 5s. to £222 10s.; Monday, £223 10s. to £223 15s.; Tuesday, £223 17s. 6d. to £224; Wednesday, £223 10s. to £223 15s.

Spelter.—Consumptive demand for ordinary spelter this week has been only moderately active, the market, however, closing with a slightly upward tendency.

Daily quotations are :—

Ordinary.—Thursday, £26 17s. 6d.; Friday, £26 18s. 9d.; Monday, £26 17s. 6d.; Tuesday, £26 16s. 3d.; Wednesday, £26 15s.

Lead.—Inquiries for soft foreign pig are only on a limited scale, and supplies are fully adequate to meet current home demands. Prices also have sagged to a trifling extent, but this may be only a temporary movement, due to seasonal conditions, and any serious decline in lead prices is not regarded as probable.

Prices have been :—

Soft Foreign (Prompt).—Thursday, £21 6s. 3d.; Friday, £21 3s. 9d.; Monday, £21 5s.; Tuesday, £21 5s.; Wednesday, £21 6s. 3d.

Derby Society of Engineers.

"Some Aspects of Steam Storage in Industry" formed the subject of a very interesting and instructive address given to the members of the Derby Society of Engineers at the Derby Technical College, by Mr. T. Nordenson. Dr. D. S. Anderson presided.

Obituary.

ROBERT W. MACCALLUM, who was for over 40 years in the employ of the Steel Company of Scotland, died at his residence in Kirkintilloch, on December 9.

THE DEATH is announced of Mr. Robert Aitken, of the Anderston Foundry Company, at Knightswood, Glasgow.

The Rise in Spelter.

By "ONLOOKER."

In colloquial language spelter has looked pretty sick for the greater part of this year, the only brief period of optimism, and it *was* very short-lived, being in May, when the market firmed up on news of the formation of the European Zinc Cartel. At that time it was announced that the intention was to keep spelter up to £26 at least, but circumstances—mainly weakness in America—were too strong for this laudable plan, and it soon became evident that values were once again on the down grade. This tendency persisted right through the summer months and well into the autumn, the lowest price for many years being touched in November, while market sentiment was just about as gloomy as it well could be. Spelter was in a rut, trade demand, apart from high grade, extremely poor, and the outlook particularly dismal.

Behind the scenes, however, negotiations had been going on between interests in Europe, who had speedily realised the impossibility of improving the situation unless a world-wide effort were made, and producers in the United States. During the greater part of this year stocks of spelter across the Atlantic have shown a rising tendency, and the price has suffered in consequence. Agreement over reduction of output is never easy, for there is always an inclination to wait for the other man to make a start first. What proved impossible within the confines of one Continent has evidently been achieved between representative interests in Europe and the United States, and on rumours that a world understanding was on the eve of fulfilment, spelter developed sensational strength in London and St. Louis.

At the time of writing no confirmation is to hand that an agreement has actually been reached, and the market is showing some signs of reacting after its rapid rise, but this is probably due to a certain amount of profit taking, and is not necessarily an indication that the bears are going to launch a counter-attack. When the change round in the fortunes of spelter occurred, the market was in a decidedly oversold condition, and the result of this was a rush to cover open commitments. To be oversold is, of course, nothing unusual for the spelter market, in which so much hedging against ore purchases is effected, and such a condition lends itself to rapid change when any signs of an advance come along. Such hedging sales, of course, have to be bought in eventually, but, generally speaking, it can be said that the London market is subject to a good deal of selling pressure throughout the year.

A feature of the rise in spelter was the lack of interest displayed by consumers, for comparatively little metal was sold. Buyers of ordinary brands of spelter are certainly not covered very far ahead, hardly beyond the end of the year, though possibly the German users, who have been more active in the market lately, may be booked up for the early months of 1929. Apart from the galvanising trade, the demand for g.o.b. spelter is not big in this country, for the brass trade exists mainly on high-grade, which is principally negotiated on an average basis worked on the prices of the London market. Production of this special quality has been speeded up during the past two years, costs have been lowered, and every encouragement has been given to consumers to avail themselves of the very best electrolytic spelter at the comparatively low extra of £2 over g.o.b.

Contrary to such metals as copper and tin, where consumption tends to improve at low prices, the demand for spelter has not broadened with the falling quotation; if anything it appears to have fallen off. For its main uses, viz., galvanising and brass making, zinc stands alone and has no rival. Competition need not therefore be feared under these heads, but for the innumerable uses to which the metal is put in everyday use it could, of course, be replaced should the price run up too high. Of this there appears to be little fear, for huge reserves of concentrates are in existence, and although secondary zinc does not come forward in great quantities, the end of the world's ore deposits is yet a long way off.

THE KEY TO BETTER CASTINGS.

3 Perfect Grades

Capponfield H.B.
(HOT BLAST)

Capponfield W.B.
(WARM BLAST)

Capponfield C.B.
(COLD BLAST)

Capponfield "H.B."

(Hot Blast)

THE blowing-in of the Capponfield Blast Furnaces meets the demand for a good class brand of South Staffordshire Foundry Iron, produced under carefully controlled conditions to comply with modern foundry requirements.

Bradley's Capponfield Hot Blast is an excellent grade of iron, supplied with low phosphorus, low sulphur and medium manganese contents. The silicon content is supplied to suit the specific requirements of each customer, and a complete analysis of each cast is available. The addition of Capponfield Iron to your mixture is highly desirable for the production of good class engineering and general castings at competitive prices. Capponfield "H.B." means Strength plus Easy Machining.

"Capponfield Quality"

Bradley's CAPPONFIELD PIG IRON

All Capponfield Irons are direct blast-furnace products. Bradley's well-known Refined Irons are made at the Darlaston Works.

BRADLEY & FOSTER LIMITED

CAPPONFIELD AND DARLASTON, STAFFS

(All communications should be addressed to Darlaston.)

TELEPHONE: DARLASTON 16 (Private Branch Exchange). TELEGRAMS: BRADLEY'S, DARLASTON

WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	68 17 6
Three months	68 12 6
Electrolytic	74 15 0
Tough	72 10 0
Best selected	72 15 0
Sheets	98 0 0
India	83 0 0
Wire bars	75 2 6
Do. December	75 2 6
Do. January	75 2 6
Ingot bars	75 2 6
H.C. Wire rods	79 5 0
Off. av. cash, November	68 2 3 7/17
Do. 3 mths., November	68 10 11 13/32
Do., Sttlmnt., November	68 2 4 7/17
Do., Electro, November	74 19 7 10/17
Do., B.S., November	73 1 4 6/17
Aver. spot price, copper, Nov.	68 2 3 7/17
Do. Wire bars, November	75 4 3 7/17
Solid drawn tubes	13½d.
Brazed tubes	13½d.
Wire	10½d.

BRASS.

Solid drawn tubes	12d.
Brazed tubes	14d.
Rods, drawn	11½d.
Rods, extd. or rlld.	7½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10½d
Yellow metal rods	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets	8½d.

TIN.

Standard cash	224 5 0
Three months	223 10 0
English	223 10 0
Bars	226 10 0
Straits	225 10 0
Australian	224 17 6
Eastern	226 15 0
Banca	225 2 6
Off. av. cash, November	232 19 5 2/11
Do., 3 mths., November	228 0 11 13/32
Do., Sttlmt., November	232 18 11 7/17
Aver. spot, November	232 19 5 2/11

SPELTER.

Ordinary	26 15 0
Remelted	24 15 0
Hard	20 0 0
Electro 99.9	29 17 6
English	27 5 0
India	21 15 0
Zinc dust (Nom.)	36 10 0
Zinc ashes	8 5 0
Off. aver., November	24 16 3 1/2
Aver., spot, November	24 16 0 5/11

LEAD.

Soft foreign ppt.	21 6 3
English	22 10 0
Off. average, November	21 7 0 3/4
Average spot, November	21 4 9 5/11

ZINC SHEETS, &c.

Zinc sheets, English	35 0 0
Do. V.M. ex whf.	33 10 0
Rods	43 0 0
Boiler plates	32 0 0
Battery plates	33 0 0

ANTIMONY.

Special brands, Eng.	57 10 0
Chinese	38 15 0
Crude	33 10 0

QUICKSILVER.

Quicksilver	22 5 9

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	7 17 6
45 50%	12 0 0
75%	19 0 0
Ferro-vanadium—	
35/50%	14/- lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/3 lb. Mo.
Ferro-titanium—	
23/25% carbonless	1/1 lb.
Ferro-phosphorus, 20/25%	£18 0 0
Ferro-tungsten—	
80/85%, c. fr.	1/5 lb.
Tungsten metal powder—	
98/99%	1/10 lb.
Ferro-chrome—	
2/4% car.	£30 0 0
4/6% car.	£21 12 6
6/8% car.	£20 12 6
8/10% car.	£20 7 6
Ferro-chrome—	
Max. 2% car.	£33 2 6
Max. 1% car.	£37 0 0
Max. 0.70% car.	£44 0 0
70% carbonless	1/- lb.
Nickel—99%, cubes or pellets	£175 0 0
Ferro-cobalt	9/- lb.
Aluminium 98 99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£13 15 0
76/80% packed	£14 15 0
76/80%, export	£14 10 0
Metallic manganese—	
94/96%, carbonless	1/6 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 3
Finished bars, 18% tungsten	£0 2 9

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to ⅛ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ½ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Hvy. steel	3 7 6	to 3 8 6
Bundled steel and shrngs.	3 4 0	to 3 8 0
Mixed iron and steel	3 2 6	to 3 3 6
Heavy cast iron	2 16 0	to 2 18 0
Good machinery for foundries	2 18 0	to 3 0 0
Cleveland—		
Heavy steel	3 0 0	
Steel turnings	2 8 0	
Cast iron borings	2 2 6	
Heavy forge	3 7 6	
Bushelled scrap	2 18 6	
Cast-iron scrap	3 2 6	
Lancashire—		
Cast-iron scrap	2 15 0	to 3 5 0
Hvy. wrought	3 7 6	
Steel turnings	2 5 0	

London—Merchants' buying prices delivered yard.

Copper (clean)	54 0 0
Brass	39 0 0
Lead (less usual draft)	19 0 0
Tea lead	16 0 0
Zinc	15 10 0
New aluminium cuttings	66 0 0
Braziery copper	50 0 0
Gunmetal	50 0 0
Hollow pewter	150 0 0
Shaped black pewter	105 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	68/6
Foundry No. 3	66/-
Foundry No. 4	65/-
Forge No. 4	64/6
Hematite No. 1	71/6
Hematite M/Nos.	71/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	78/-
,, d/d Birm.	85/6
Midlands—	
Staffs. common*	67/6
,, No. 4 forge	56/-
,, No. 3 fdry.	60/-
Shrops. basic	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge	52/6
,, fdry. No. 3	55/6
Derbyshire forge	59/-
,, fdry. No. 3	60/6
,, basic	65/-
Scotland—	
Foundry No. 1	75/-
,, No. 3	70/-
Hem. M/Nos.	74/-
Sheffield (d/d district)—	
Derby forge	61/-
,, fdry. No. 3	63/-
Lincs. forge	63/-
,, fdry. No. 3	65/6
E.C. hematite	81/-
W.C. hematite	82/6
Lincs. (at furnaces)—	
Forge No. 4	58/6
Foundry No. 3	61/-
Basic	60/-
Lancashire (d/d eq. Man.)—	
Derby forge	—
,, fdry. No. 3	67/6
Northants foundry No. 3	—
Dalzell, No. 3(special)	100/- to 102/6
Summerlee, No. 3	87/6 to 90/-
Glengarnock, No. 3	87/6 to 90/-
Gartaherrie, No. 3	87/6 to 90/-
Monkland, No. 3	87/6 to 90/-
Shotts, No. 3	87/6 to 90/-

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d.	£ s. d.
Bars (cr.) nom.	10 5 0	
Nut and bolt iron	8 12 6	to 8 17 6
Hoops	11 10 0	
Marked bars (Staffs.) f.o.t.	12 0 0	
Gas strip	11 10 0	
Bolts and nuts, ½ in. × 4 in.	15 5 0	
Steel—		
Ship plates	8 7 6	to 8 12 6
Boiler plts.	10 10 0	
Chequer plts.	10 12 6	
Angles	7 17 6	
Tees	8 17 6	
Joists	7 17 6	
Rounds and squares, 3 in. to 5½ in.	8 17 6	
Rounds under 3 in. to ¾ in. (Untested)	7 15 0	and upwards
Flats, over 5 in. wide and up	8 7 6	
Flats, 5 in. to 1½ in.	7 17 6	
Rails, heavy	8 10 0	
Fishplates	12 10 0	
Hoops (Staffs.)	10 10 0	
Black sheets, 24g.	10 0 0	to 10 10 0
Galv.cor.shts.24g.	13 7 6	to 13 12 6
Galv. fencing wire 8g. plain	12 10 0	
Billets, soft	6 5 0	to 6 12 6
Billets, hard	7 0 0	to 7 12 6
Sheet bars	6 0 0	
Tin bars	6 0 0	

PHOSPHOR BRONZE.

	Per lb. basis
Strip	1 2⅝
Sheet to 10 w.g.	1 3½
Wire	1 4⅛
Rods	1 3½
Tubes	1 7⅛
Castings	1 2½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.60
No. 2 foundry, Birm.	16.50
Basic	19.26
Bessemer	20.79
Malleable	20.01
Grey forge	19.26
Ferro-mang. 80% d/d	105.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars	33.00
Wire rods	42.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.95
Tank plates	1.90
Beams, etc.	1.90
Skelp, grooved steel	1.90
Skelp, sheared steel	1.90
Steel hoops	2.20
Sheets, black, No. 24	2.85
Sheets, galv., No. 24	3.50
Sheets, blue an'l'd, 9 and 10	2.00
Wire nails	2.55
Plain wire	2.40
Barbed wire, galv.	3.20
Tinplates, 100 lb. box	$5.25

COKE (at ovens).

Welsh foundry	—
,, furnace	—
Durham and North.	
,, foundry	16/-
,, furnace	14/-
Midlands, foundry	—
,, ,, furnace	13/- to 14/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes	20×14 box	18/-
,,	28×20 ,,	36/-
,,	20×10 ,,	26/3
,,	18½×14 ,,	18/9
C.W.	20×14 ,,	14/9
,,	28×20 ,,	33/6
,,	20×10 ,,	21/-
,,	18½×14 ,,	15/-
Terneplates	28×20	33/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 10 0
Bars, hammered, basis	£17 10 0 to £18 10 0
Bars & nailrods, rolled, basis	£15 15 0 to £16 15 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£20 0 0 to £24 0 0
Bars & rods, dead soft, steel	£10 0 0 to £14 0 0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings.*
Gas	67½%	50%
Water	63½%	45%
Steam	60%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Dec. 13		68	5	0	dec.	1/3
,, 14		68	3	9	,,	1/3
,, 17		68	8	9	inc.	5/-
,, 18		68	16	3	,,	7/6
,, 19		68	17	6	inc.	1/3

Electrolytic Copper.

	£	s.	d.	
Dec. 13	74	15	0	No change
,, 14	74	15	0	,, ,,
,, 17	74	15	0	,, ,,
,, 18	74	15	0	,, ,,
,, 19	74	15	0	,, ,,

Standard Tin (cash).

	£	s.	d.		
Dec. 13	226	7	6	inc.	22/6
,, 14	224	5	0	dec.	42/6
,, 17	224	10	0	inc.	5/-
,, 18	224	17	6	,,	7/6
,, 19	224	5	0	dec.	12/6

Tin (English ingots).

	£	s.	d.		
Dec. 13	225	5	0	inc	25/-
,, 14	223	0	0	dec.	45/-
,, 17	224	0	0	inc.	20/-
,, 18	224	10	0	,,	10/-
,, 19	223	10	0	dec.	20/-

Zinc Sheets (English).

	£	s.	d.	
Dec. 13	34	10	0	No change
,, 14	35	0	0	inc. 10/-
,, 17	35	0	0	No change
,, 18	35	0	0	,, ,,
,, 19	35	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.		
Dec. 13	26	17	6	inc.	2/6
,, 14	26	18	9	,,	1/3
,, 17	26	17	6	dec.	1/3
,, 18	26	16	3	,,	1/3
,, 19	26	15	0	dec.	1/3

Lead (English).

	£	s.	d.	
Dec. 13	22	10	0	No change
,, 14	22	10	0	,, ,,
,, 17	22	10	0	,, ,,
,, 18	22	10	0	,, ,,
,, 19	22	10	0	,, ,,

Exports of Iron Castings in November and the eleven months 1928, compared with November and the eleven months 1927.

	November, 1927.	November, 1928.	Eleven months, 1927.	Eleven months, 1928.	November, 1927.	November, 1928.	Eleven months, 1927.	Eleven months, 1928.
BUILDERS' CASTINGS—								
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers:—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
To Argentine Republic	147	169	1,456	1,691	4,935	7,406	54,321	68,786
,, British South Africa	450	464	2,862	3,295	15,873	14,610	103,205	115,081
,, ,, India	156	185	1,102	1,363	8,552	6,697	51,486	57,910
,, Australia	80	51	853	575	4,487	3,653	49,300	39,979
,, New Zealand	244	131	1,901	1,682	12,832	7,748	97,556	88,308
,, Other countries	1,180	1,064	8,098	8,663	51,159	48,849	397,899	404,590
Total	2,257	2,064	16,272	17,269	97,838	88,663	753,767	774,654
PIPES AND FITTINGS—CAST—								
To Argentine Republic	913	950	8,751	8,834	10,695	7,773	97,374	87,821
,, British South Africa	2,362	336	13,898	4,924	22,132	5,302	152,316	70,456
,, ,, India	643	495	6,447	7,176	8,584	7,019	98,245	97,314
,, Straits Settlements and Malay States	1,683	1,927	14,092	15,885	16,769	17,217	138,496	141,865
,, Ceylon	46	53	1,231	3,324	577	874	14,453	31,250
,, Australia	1,166	1,167	8,880	9,880	12,139	9,362	104,984	102,256
,, Other countries	6,064	6,026	57,906	52,720	83,253	64,195	757,037	671,866
Total	12,877	10,954	111,205	102,743	154,149	111,742	1,362,905	1,202,828
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	522	551	4,430	4,368	21,039	20,746	173,984	165,709
,, Enamelled	83	82	662	734	9,104	7,318	69,174	70,156
CASTINGS, in the rough—								
Iron	225	89	1,220	1,459	5,643	3,269	41,901	47,071
Steel	68	108	924	691	3,042	4,901	42,858	29,684

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

PIG IRON

REGISTERED TRADE MARK

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

SITUATIONS VACANT AND WANTED.

METALLURGIST, capable of taking complete control of grey iron and non-ferrous foundries, desires change; exceptional experience in the production of steel mix and alloy grey iron castings for high pressure work; University graduate, with thorough practical training.—Full particulars on application to Box 930, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVE required for London and Southern Counties for Sale of well-known brand of Pig-iron; must be well known with the Foundry Trades and export; expenses and good commission paid to suitable applicant. —Write and give full particulars to Box 928, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

TENDER.

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive Tenders for the supply of the undermentioned Iron and Steel Goods.

2.—Helical and Volute Springs.
3.—Tyres and Rolled Steel Wheel Centres.
4.—Steel Axles and Forgings.
5.—Iron Plates and Bars.
6.—Steel Plates and Bars.
7.—Steel Bars and Blooms.
8.—Steel Castings (Wheel Centres).
9.— do. (Miscellaneous).
11.—Chain and Iron for Chain Manufacture.
12.—Tubes and Fittings.
13.—Cold Drawn Steel Tubes.
14.—Cast Iron Socket, etc., Pipes and Iron Castings.
15.—Galvanised Sheets.

Specifications and Forms of Tender (upon which alone Tenders will be received) may be obtained on application to the Stores Superintendent at Swindon.

Tenders addressed to the undersigned and marked outside "Tender for Iron and Steel" will be received not later than 10.0 a.m. on Tuesday, January 8th, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

F. R. E. Davis, Secy.

Paddington Station, London, W.2,
18th December, 1928.

SALE BY PRIVATE TREATY.

TRAFFORD PARK, MANCHESTER.

For Sale by Private Treaty at a bargain price.

MODERN FOUNDRY—ERECTED 1921, with Railway Sidings into Works. Excellent Warehouse and Packing Room and fine Suite of Offices. Area of land 7,173 sq. yds., of which 2,850 are covered by a one-storey erection on same level. Easily adaptable for other trades.

To treat: F. S. Airey, Entwistle & Company, 10, Norfolk Street, Manchester.

PROPERTY.

11 ACRES WORKS SITE, SHEFFIELD.

145,000 Sq. Ft. of SHOPPING, Compact and Convenient.

SIDING CONNECTIONS

with L.M. & S. and L. & N.E. Rlys.

WELL-BUILT & COMMODIOUS OFFICES

Will Sell whole or in lots to suit customers, or Let on favourable terms. Unique opportunity for Manufacturers.

Apply—

THOS. W. WARD, LTD.,
ALBION WORKS, SHEFFIELD.

PROPERTY.—*Continued.*

FREEHOLD BUILDINGS AND OFFICES covering 13,000 sq. ft., adjoining Station. —Girlings, Maldon, Essex.

PATENTS AND TRADE MARKS.

THE Owner of British Patent No. 247,683 and Patent of Addition No. 249,313, relating to "A Machine or Apparatus for Treating or Preparing Moulding-sand and for Analogous uses," is desirous of entering into negotiations for the grant of licences or otherwise, under reasonable terms, for the purpose of exploiting the invention and ensuring its full development and practicable working in this country.—For particulars address Arthur Sadler, 44, Waterloo Street, Birmingham.

MACHINERY.

WANTED, good secondhand Moulding Machines, for rapid production of repetition castings.—Box 932, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SAND MIXERS.—New and second-hand. Ask us to quote.—W. Brealey & Company, Limited, Prospect Works, Hawksley Avenue, Sheffield.

New 9-in. centres Combination Turret Lathe on 8 ft. 3 in. bed, all geared, S.P.D.

New 7 in. centres Combination Turret Lathe on 6 ft. 6 in bed, all geared, S.P.D.

New Capstan Lathes, 1 in. and 2 in. holes through spindles; bargains.

New 8 in. centres Relieving Lathe on 4 ft. 3 in. bed.

Two 20-h.p. "Simplex" PETROL LOCOMOTIVES (Motor Rail and Tramcar Co.), 2-ft. gauge, two cylinder "Dorman" Engine.

One 40-h.p. "Simplex" PETROL LOCOMOTIVE (Motor Rail and Tramcar Co.), 2-ft. gauge, four cylinder "Dorman" Engine.

50-ton "Denison" TRUCK WEIGHBRIDGE, platform 16 ft. x 8 ft., 4-ft. 8½-in.-gauge rails, no-loose-weight steelyard.

Two 40-ton "POOLEY" TRUCK WEIGHBRIDGES, platforms 22 ft. x 6 ft., 4-ft. 8½-in. gauge, no-loose-weight steelyard.

Two LANCASHIRE BOILERS, 30 ft. x 8 ft., reinsure 110 lbs. pressure.

A number of open-top Wrought Iron or Steel Cisterns, each 3 ft. x 8 ft. x 8 ft. deep x about 3/16 in. thick, capacity about 3,200 gallons each.

CATALOGUE (10,000 Lots) ON APPLICATION.

THOS. W. WARD LTD.,
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